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VOLUME II

PARTS SPECIFICATION MANAGEMENT FOR RELIABILITY

MAY 1960

AD HOC STUDY GROUP ON PARTS SPECIFICATION MANAGEMENT FOR RELIABILITY
OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING AND
OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE SUPPLY AND LOGISTICS

Volume II

PARTS SPECIFICATION MANAGEMENT FOR RELIABILITY

Volume I.	Volume II.
Task Assignment	Concepts and Objectives
Recommendations	Prototype Specifications
Subtask Reports	Form and Instructions

Ad Hoc Study Group on Parts Specification Management for Reliability
Office of the Director of Defense Research and Engineering
and
Office of the Assistant Secretary of Defense (Supply and Logistics)
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FORSWORD

The fast-changing state of the electronics art, together with increasingly complex equipments demanding high reliability, has created the need for (1) additional requirements in electronic parts and tubes specifications, (2) faster coordination of parts specifications, (3) the establishment of technical characteristics data for dissemination to design and logistics personnel and (4) a complete review of the parts specifications program to ensure compatibility with the reliability program. These basic needs were recognized and reported by Task Group 5 of the Advisory Group on Reliability of Electronic Equipment in its report dated 4 June 1957.

Accordingly, the Ad Hoc Study Group on Parts Specifications Management for Reliability was established by a memorandum of agreement dated 14 July 1958 under the joint sponsorship of the Office of the Assistant Secretary of Defense (Research and Engineering) and the Office of the Assistant Secretary of Defense (Supply and Logistics). The basic objective of the study was to analyze the recommendations of the AGREE Task Group 5 and advise the sponsors regarding efficient implementation methods and procedures.

This report, which contains the findings and recommendations of the Study Group, is issued at this time for informational purposes only.

In view of the study's wide scope, the Group's recommendations will exert a major impact on many groups in both government and industry and at levels from management down to the many technical and service activities. Many of the procedures recommended radically depart from methods now used; however, only through these new techniques can we gain the achievable benefits that are needed to meet present design demands.

Moreover, this report indicates that the time schedule is critical and that maximum benefits will be obtained only if the recommendations are carried out immediately. Again, this poses a challenge to all the interested governmental and industrial activities.

The prototype specifications and standard format for design and documentation are offered, not as the ultimate, but as guides to a methodology. In our rapidly advancing technology, new and better developments may be expected by the time the total program outlined in this report can be implemented.

Accordingly, all recipients of this report are urged to use any of this material that may be useful and appropriate to their activities.

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CONTENTS

FIGURES

TABLES

1. CONCEPTS AND OBJECTIVES

FOR THE PREPARATION OF SPECIFICATIONS

EMBODYING FAILURE-RATE REQUIREMENTS

1.1 Introduction.

The electronic-part failure rates required by the Military Departments are so low that extremely large numbers of units must be tested for long periods of time to ensure the attainment of those rates with any reasonable degree of confidence. The assurance (with 90-percent confidence) of a failure rate of 0.1 percent per 1000 hours, for example, requires over 2 million unit hours of test without a failure, or nearly 4 million hours with no more than a single failure. It is obvious that the assurance of even this moderate failure rate on an individual-lot basis is entirely impractical. We must develop a new approach to specifying inspection requirements that will ensure the desired failure rates without demanding an unrealistic and uneconomical amount of inspection.

Based on the concept described here, procedures are furnished for accumulating, over an extended period of time, the objective evidence of reliability generated by the parts manufacturer's performance of the specified acceptance inspection. Thus, means are provided by which the maximum failure rate of the product can be estimated with a high degree of confidence and certified by the qualifying activity. In addition to the life-test provisions of the acceptance inspection requirement, this approach permits the extension of life tests beyond the end point specified for acceptance--or for increasing the number of sample units life-tested in each lot--to permit the rapid accumulation of failure-rate data. Qualification- and acceptance-inspection procedures are modified for over-all consistency.

In the following sections, this concept is described in detail, and certain other pertinent guidelines for preparing electronic-parts specifications embodying failure rates are delineated.

1.2 Basic Concept.

The specifications should be based upon the concept of qualification inspection and re-evaluation, acceptance inspection and failure-rate testing, as described below:

1.2.1 Qualification Inspection: Initial qualification should be based on the results of inspection performed on a large enough sample to provide a reasonable assurance that the part type has a failure rate lower than a specified nominal figure. For this purpose, confidence limits should be set at a low value, 80 percent or less. Simplifying assumptions and acceleration factors, based on good engineering judgment and experience, should be established where practical to keep sample sizes within economical limits. The specified failure rate should be established as the maximum allowable figure that would be economical for initial production or low-production items. Normally, this failure rate should be equal to, or less than, the production failure rate (assured with the same confidence) of the current applicable military specification.

1.2.2 Re-evaluation of Qualification: Continued evaluation of qualification should be based on objective evidence that units from current production (1) have a failure rate that does not exceed the specified failure rate and (2) can pass the qualification tests. The first calls for the systematic accumulation and analysis of life-test data generated by acceptance-inspection operations. The second requires that a sample, representing some fixed period of production, be subject to selected tests of the group comprising qualification inspection.

1.2.3 Acceptance Inspection: Where possible, acceptance inspection should be on the basis of lot-by-lot sampling, including tightened or reduced inspection to ensure maximum protection with minimum sample size. Sample sizes for acceptance of lots at the failure rate for which initial qualification is granted should be based on a higher confidence level than that used for the qualification-approval tests (80 to 90 percent). At the lower failure rates (for which certification has been based on accumulated data and a high confidence level, as indicated in section 1.2.4), sample sizes should be restricted to economically practical quantities. There should be maximum use of recognized acceleration testing techniques. Provision should be made for the loss of qualification approval by a manufacturer whose product's failure rate exceeds the approved level.

1.2.4 Failure-Rate Testing: It should be provided that records of acceptance life tests be maintained, including the number of items tested, the number of failures and the time to failure, for use in determining actual failure rates. These records must include all tests, whether the lot is accepted or not. In addition, some percentage of the lot-acceptance life tests should be continued beyond the end of the acceptance testing period to the maximum time determined by the expected life. The data accumulated from lot-acceptance and extended life tests on all units placed on test within a specified maximum past period of time should be used to periodically compute maximum probable failure rates at a high (90 to 95 percent) confidence level. As an alternative to the computation, charts or tables may be provided in the specification. The specification should set forth procedures by which the manufacturer can obtain certification of a failure-rate level when his product's computed failure rate is lower than one of the established levels. Conversely, the manufacturer should be subject to the loss of approval if the maximum failure rate so computed exceeds a specified maximum value for the part. (See section 1.3.4.)

Beginning with the initial failure rate determined by qualification tests, or the first lot-acceptance tests, failure-rate requirements should be gradated to the lowest figure necessary to meet the reliability specifications of the most complex or critical equipments. In the failure-rate-testing procedures, the specification should provide for five established failure-rate levels,[1] of which the highest should be no higher than the specified level in the current corresponding military specification.

[1]It should be noted that the word "grade" is not used here, for it is felt it connotes a degree of differentiation in quality class that is not inherent in the product. The designation "established failure-rate level" gives a current, dynamic description of the character of the product.

In addition, levels of 1, 0.1, 0.01 and 0.001 percent per 1000 hours at maximum rated operating conditions should be specified. In cases where the lower failure-rate values are beyond the state of the art at maximum rated conditions, or where it is impractical to establish the level directly because of the number of unit hours of test required, derating information should be included in the specification. Units meeting each failure-rate level should be identified by appropriate designations.

1.3 Additional Factors To Be Included.

1.3.1 Criteria for Test Requirements: Tests and test requirements (except failure-rate levels) should be within the state of the art; i.e., existing data must establish that at least one manufacturer can produce an item to meet the specified requirements.

1.3.2 Failure-Rate Computation: The specification should furnish a method for accumulating the necessary failure-rate data and computing failure rates. In the computation of failure rates, standard statistical procedures should be employed, and an exponential failure distribution assumed. The acceptance sampling plans should incorporate a procedure for assuring the consumer adequate protection.

1.3.3 Rapid Determination of Failure Rate: In addition to setting forth procedures establishing failure-rate levels gradually (see section 1.2.4), the specification should permit their rapid determination by testing larger numbers of items from each production lot. In such instances, however, a minimum proportion of the total unit hours accumulated in extended life tests should be specified to ensure that the failure rate is not solely based on the abbreviated tests normally used for acceptance inspection.

1.3.4 Conditions Affecting Failure Rates:

1.3.4.1 Minor Changes: Obviously, the inspection procedures in a specification must be based on an assumption that design processes and materials are stable. To support this assumption, the inspection procedures must indicate whether an accumulation of minor changes has significantly affected the ability of current production units to meet the qualification requirements. To this end, certain tests in the qualification group should be required at regular intervals on a sample of units representing current production.

1.3.4.2 Accidental or Unusual Conditions: On evidence that an item's failure rate has risen appreciably above an established level, the certification of the established failure-rate level should be revoked and the manufacturer should either be certified at the next higher failure-rate level or lose qualification approval, as appropriate. However, the specification should include a provision to protect the manufacturer against such action when the failures were the result of accidental or unusual conditions and did not reflect a true deterioration in the failure rate.

1.3.5 Correlation Factors: When the testing limits or environments are not identical with the usage requirements, a correlation factor should be established and made a part of the specification to provide failure rates at appropriately rated conditions of end use. It is recognized that these correlation factors must be established initially on the basis of available data, which may be incomplete, and therefore these correlation factors must be based on experience and good engineering judgment.

1.3.6 Manufacturer's Responsibilities: The responsibility for performing the required tests and keeping the necessary records should be the manufacturer's. He is also responsible for informing the qualifying activity whenever his product's failure rate falls below the next lower established level.

2. PROCEDURE FOR INCORPORATING RELIABILITY-ASSURANCE PROVISIONS INTO PARTS SPECIFICATIONS

2.1 Introduction.

This procedure is designed primarily for use in the initial stages of a broad program to incorporate reliability-assurance provisions into specifications for a wide variety of parts.

A program of this kind involves many different problems, of which all cannot be solved by this procedure. For example, some specifications embody no life-test requirement, and sometimes when they do this procedure is not suitable for the specified life test. Since the incorporation of reliability assurance into specifications is quite complex even under normal conditions, it is to be expected that some specifications will require special treatment that will depart in some aspects, or entirely, from this method.

In the procedure it is recognized that the life-test requirements in many existing specifications do not prevent the acceptance of a product with a relatively high failure-rate level, even though some products may have attained significantly lower rates. Provisions are made to protect against the acceptance of failure rates that exceed levels commonly attainable and to qualify the product at lower levels, based upon data generated by the life tests. A series of failure-rate levels is specified, and this permits items to qualify for the lowest level attainable within the state of the art either now or in the foreseeable future.

The procedure also recognizes that a balance must be maintained between the cost of life testing and the satisfactory assurance that a product conforms to the specified failure-rate level. At the higher levels, individual-lot protection in the form of a fixed LTPD (lot tolerance percent defective) is provided at a high confidence level. At the lower levels, where sample sizes and/or the duration of life test for individual-lot assurance with equal protection and high confidence would tend to become prohibitive, individual-lot assurance at high confidence is provided by a fixed AQL (acceptable quality level) type of sampling. Protection in the form of a fixed LTPD type of sampling is simultaneously provided through the analysis of data accumulated from several consecutive production lots.

2.2 Scope of the Specification-Revision Problem.

The incorporation of reliability-assurance procedures into military parts specifications makes it necessary to change the procedures for initial qualification and for acceptance testing and to add procedures for certifying failure-rate levels.

In addition, many specifications require changes that are not directly related to the quantitative reliability-assurance procedures but are needed to make the specifications more meaningful. The more important changes of this nature are explained in the following paragraphs:

2.2.1 Responsibility for Performing Specified Inspection: A statement regarding the manufacturer's responsibility for the performance of specified inspection must be added to the quality-assurance provisions of many specifications. Some rewording of other paragraphs may be necessary to eliminate possible conflicts with this statement.

2.2.2 Qualification Inspection: Most specifications require a qualification inspection of the product. Sometimes the requirement is described in the quality-assurance provisions of the specification, but on other occasions it is described partly in an appendix. To eliminate these unnecessary variations in form, the requirement should be described in the specification's quality-assurance provisions.

2.2.3 Combined Qualification: Many specifications permit a form of blanket qualification called a combined submission. For example, the qualification-approval tests are conducted on a sample made up of equal numbers of two styles of the same component type, and if the sample complies with the requirements both styles are approved. These provisions should be carefully reviewed to ensure that the combination of the styles involved is valid with respect to characteristics affecting reliability.

2.2.4 Periodic Inspection: Some specifications require all applicable tests to be performed on a qualification sample and on a sample from each inspection lot (see paragraph 2.2.5). Others require all tests to be performed on a qualification sample, but not on a sample from each lot. Specifications must be revised to require, following the initial qualification inspection, periodic requalification tests on samples from current production. At the same time, the revised specification must require, as a minimum, reliability-assurance tests on a sample from every lot produced.

2.2.5 Inspection Lots: Many specifications call for the formation of "inspection lots," which may consist of an indefinite number of production lots of items that are not necessarily alike. The specifications should require that the inspection lots consist of items likely to be homogeneous.

2.2.6 Grouping of Inspections: In many specifications, certain examinations and tests are required at stated intervals, when they should be made on a sample from each production lot. In the revised specifications, these inspections must be regrouped so that they will serve the intended purpose.

2.2.7 Process Average: In most specifications containing a paragraph on resubmitted lots, the wording can lead to a misunderstanding of its intention. Paragraphs concerning lots resubmitted for inspection under the provisions of MIL-STD-105 must clearly state that data pertaining to lots rejected shall be included in the computation of the process average, regardless of the eventual disposition of those lots. Similarly, data from any lot failing to meet the life-test provisions must be included in failure-rate-certification calculations, which are based on tests of consecutive lots, without regard to ultimate conclusions concerning the rejected lot.

2.8. Life Tests: The life tests in various parts specifications are treated inconsistently with respect to the nature and conditions of the test. Each so-called life test should be carefully analyzed to ensure that it is truly a test of the part's life and not merely an exposure to extreme electrical, mechanical or other environmental conditions.

In some instances, life tests are performed at less than the maximum operating conditions under which the item is to perform. Life tests should be conducted under maximum rated conditions--and even higher, if possible--to take advantage of any accurately known acceleration factor provided by higher temperature, voltage, etc.

2.2.9 In-Process Inspection: Many specifications call for certain inspections after the item is completed, even though it is impossible, or economically impractical, to do so at that time. Provisions for carrying out all necessary examinations and test at suitable times (during or after the manufacturing process) should be included in the specifications.

2.3 Basic Approach.

As indicated by the foregoing discussion, parts reliability can be guaranteed only if existing quality-assurance provisions are revised and augmented with suitable provisions tailored to the following objectives:

(1) Define the attainable reliability in terms of a set of appropriate failure-rate levels bracketing the present and the future states of the art;

(2) Regroup inspections so that they will achieve the required results; and

(3) Revise quality-assurance procedures and add reliability-assurance procedures which provide the desired statistical protection.

2.4 Quantitative Expression of Reliability.

The expression of required reliability in quantitative terms is needed to provide a common basis for comparing the reliability of one part with another's and with the reliability demanded by military usage. Whatever quantitative expression is used, it must have a sound statistical meaning, and the meaning must be the same in all parts specifications.

An ideal way to express reliability would be in the form of a single number which, by its numerical value, would indicate the degree of a product's reliability. This characteristic, however, can only be estimated, and the accuracy of the estimate is affected by more than one factor. Whatever quantitative term is used, its numerical value may be meaningless unless all the factors on which it is based are specifically defined or clearly understood.

The most suitable quantitative term for expressing the reliability of component parts is commonly known as failure rate and is usually expressed as percent failures per X hours (or cycles) of operation. This is a condensed version of the following expression:

> When operated continually at C% of its rated capacity, there is a P% likelihood that the product will have a failure rate that does not exceed F% failures per X hours (or cycles) of operation.

Obviously, the numerical value for F depends on the values for C, P and X. It also frequently depends on the environmental conditions, especially temperature, and if pertinent these should be included in any reliability statements. The values for C, P and X should be selected in accordance with the following:

(1) C: This value should be established at 100, although a product in actual use is seldom operated continuously at 100 percent of rated capacity. While this value for C will result in specified failure rates higher than those to be expected of parts in operational use, it provides a suitable base for comparison, evaluation and derating, where the necessary derating factors are known. When acceleration factors are known with a reasonable accuracy, life tests should be performed at higher values of rated capacity, but results should still be stated in terms of C = 100.

(2) P: The value selected for P will depend on the amount of protection desired and the cost of attaining the desired level. A figure of 90 is commonly used in statements of statistical confidence, but where the amount of data available is small this usually results in a guaranteed failure-rate figure considerably worse than the "best estimate" required by the designer. Accordingly, a lower value of P, which narrows the gap between the guaranteed figure and the designer's best estimate and reduces the otherwise prohibitive cost of assurance, is then preferred. Under such circumstances, a lower value for P is justified.

(3) X: The value of X, insofar as is practical, should be set at a consistent value for all specifications. Where the time scale is measured in hours, the figure 1000 is generally accepted and should be used. In cases where the time scale is measured in operations (e.g., switches, relays or connectors), the use of some other standard decade value may be justified to obtain failure-rate figures more representative of actual usage. The base figure, however, should not be so large as to imply a capability that is not inherent in the part.

2.5 Specified Failure Rates.

As indicated in the foregoing definition, the value of F represents a guarantee limit whose magnitude is a function of the testing economics for the component part concerned. When a reliability-assurance provision is incorporated into a specification, the highest value for F should be no greater than that permitted by the existing specification, and the value may well be lower if it is known that present market requirements and competitive suppliers' performances do not warrant an approved failure rate as high as that currently permitted.

To cover the range between the highest failure rate (determined as indicated above) and the lowest failure rate that is of value in future designing, a series of failure-rate levels can be specified with provisions that call for marking the product according to the level it meets. The series should be based on decade steps, since these are sufficient for guarantee purposes and the additional administrative effort needed for closer spacing of the steps is not justified.

2.6 Failure-Rate Inspection.

Failure rates are determined by subjecting the product to some form of testing that simulates operation under conditions of actual use. In many specifications this is called a life test, but there is no standard terminology and the test itself may not be specified.

When such a test is specified, it is usually required for qualification approval; it may also be performed periodically. The life-test requirement must be revised to make it suitable for (1) acceptance inspection on a lot-by-lot basis and (2) failure-rate certification on a cumulative basis. For acceptance purposes, an average outgoing failure rate, at or below the certified level, may be economically preferable, especially at the low levels over the fixed LTPD form of test. For certification, the sequential accumulation of part hours and failures from the lot-by-lot acceptance tests makes it possible to assure a specified failure-rate level at a nominal risk to the consumer (namely, 90 percent confidence) without great delay or special expense.

2.7 Qualification Procedure.

In the procedure under discussion, a product is qualified at the highest specified failure-rate level when the product manufacturer meets the qualification-inspection requirements. In addition, a product will be certified at a lower failure-rate level when the manufacturer meets failure-rate inspection requirements for the lower failure-rate level. Present basic qualification procedures can be easily amended to provide this added function, and approved sources of supply for qualified electronic parts lists can be extended to show the lowest certified failure-rate levels. Maximum failure-rate levels for qualification must be no higher than those for which there is an actual market, because, without advantages in performance, weight, volume, cost or availability, there is no justification for qualifying any manufacturer at failure rates worse than those established by competing firms. Accordingly, it may be necessary to determine the highest failure-rate levels allowable for qualification on the basis of experience gained in the practice of the procedure recommended here. In any case, no failure rate higher than any present specification allows should be permitted, even on a temporary basis. (See section 2.8.2.)

2.8 Revision Procedure.

This section is a step-by-step outline of the procedure for revising current specifications. The content of existing specifications varies to such an extent that it is impossible to identify specific paragraphs that must be revised. Nor is it possible to speak of revising paragraphs in the order in which they will appear in the revised version.

The revision procedure consists of the following steps:

(1) Identification, regrouping and analysis of inspections;
(2) Determination of failure-rate levels and the qualification approval sample;

(3) Determination of requirements for acceptance life-test sampling;
(4) Determination of criteria for certification and revocation of failure rates.

2.8.1 Identification, Regrouping and Analysis of Inspections:

2.8.1.1 Identification and Regrouping: The first step is to identify the life-test requirement from which the failure-rate levels are to be derived. In most specifications this requirement is entitled "life test" or "endurance test." In others there may be no life-test requirement, or the requirement as specified may be incomplete, indefinite or difficult to recognize. The identification process can be facilitated by regrouping the requirements on the basis of certain elements (listed below) that are common to the examinations and tests in the same group:

Group 1, Conformance Inspection: These are intended to detect deviations (from standards established by the design) that are attributable to manufacturing errors. This kind of inspection can be identified as an examination or test that involves a measurement or a comparison with a design standard.

Group 2, Environmental Tests: The purpose of these tests is to ascertain whether a part conforming to design standards can withstand certain environmental conditions to which it may be subjected in operational use, storage or handling. The tests can be identified by the inclusion of an environmental conditioning requirement (e.g., subjection to shock, vibration, temperature variation, etc.), during or after which certain tests are repeated to detect any changes in the part's conformance to design standards.

Group 3, Life Tests: These are intended to ensure that parts conforming to design standards are sufficiently free from susceptibility to failure to fall within the limits set for maximum failure rate--the tested parts' ultimate failure being either catastrophic or outside specified performance limits. These tests can be identified by their specification of a number of hours or cycles of functional operation during which conformance tests are employed to determine whether the part has failed.

This kind of regrouping is necessary, not only to identify the life-test requirement, but to correct such inadequacies as making conformance inspections periodically when they should be made on samples from each lot, or performing environmental tests on each lot when periodic testing gives adequate protection.

2.8.1.2 Analysis: When the examinations and tests in a specification are identified and classified into groups designed for a common purpose, it is possible to determine the amount of inspection required for each group. Suitable sampling plans can then be selected to ensure that each group provides the necessary protection. The nature of this protection can be determined by the following analysis:

(1) Conformance inspections are intended to uncover defects that may occur in any unit of product at any time in the manufacturing process. Samples should be taken from lots that contain all of the product and are homogeneous in form.

(2) Environmental tests are intended to demonstrate that satisfactory performance is attainable during--or after, as specified--exposure to conditions

of external stress that are likely to be encou... ..d or that are known or suspected to be deleterious to performance or life. Not only do these tests verify the adequacy of product design, but they ensure the adequacy of materials used in fabrication, the manufacturing and procurement specifications employed and the inspection performed. Based upon the degree to which the product's performance depends on operating or storage environment and because of the impermanence of any demonstrated assurance, environmental tests may be required on a lot-by-lot basis, rather than less frequently.

(3) Life tests are intended to ensure that the parts are free from susceptibility to a variety of failure mechanisms, ranging from certain combinations of normal variations in design and construction to adverse sensitivity to environment and other external stimuli.

2.8.2 Determination of Failure-Rate Levels and the Qualification Approval Sample: The highest failure-rate level should be chosen after consultation with industrial representatives, taking into account failure rates now applicable to products currently available at a minimum cost, as well as the scope and cost of the assurance testing needed to attain a reasonable degree of confidence that the maximum failure rate is not exceeded. It must be clearly understood that the qualification level is in the nature of a guarantee and therefore may be somewhat higher than the "best estimate." The initial qualification-approval level should be no higher than the level computed from the life-test requirement in the existing specification, but it should not be so low as to preclude the approval of a new source of products of a reasonable and controlled quality simply because the initiation of the long-term procedure might constitute an economic hurdle.

The second failure-rate level should be set at the next lower decade value, and the remaining levels, at successively lower decades.

The size of the initial qualification sample should be computed on the basis of the highest failure-rate level and a confidence level of 80 percent or lower. For this purpose, a single-sampling test plan should be employed.

2.8.3 Determination of Requirements for Acceptance Life-Test Sampling: The acceptance test chosen for the highest failure-rate level should be designed to limit the user's risk at that failure rate, taking into account the item's cost, the test time and the acceleration factor, if applicable. The confidence level should be somewhat higher than that used for the initial qualification approval, but it need not be as high as the level used for the failure-rate certification. A confidence level of 80 to 90 percent, therefore, should be used for this purpose.

For the lower failure-rate levels, sample sizes for a limited consumer's risk (high confidence level) and low failure rates become unduly large, especially if acceptance numbers higher than zero are used--as they must be to limit the producer's risk to a reasonable value. It is therefore practical to resort to the type of acceptance protection inherent in MIL-STD-105, namely, that of an adequate average outgoing failure-rate level for continuous production. Thus the consumer's risk can be progressively increased at the lower levels. This is justifiable, since the failure-rate level will be continuously certified by sequential analysis of data from acceptance and extended life tests to limit the risks of both producer and consumer. Acceptance sampling plans may be of the single-sample or the sequential type.

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2.8.4 Determination of Criteria for Certification and Revocation of Failure Rates: Procedures should be established for the accumulation of data on the acceptance tests and, where desirable, on extended life tests. The data should be analyzed by sequential-analysis techniques.

Excellent treatments of this subject will be found in the following:

(1) Epstein, B. Handbook on Statistical Techniques in Life Testing, Chapter II, "Testing of Hypothesis." October 1958.

(2) Epstein, B. and Sobel, M. "Sequential Life Tests in the Experimental Case," Annals of Mathematical Statistics. March 1955.

(3) Wald, A. Sequential Analysis. New York: John Wiley and Sons, 1948.

The criteria for certifying failure-rate level should be based on a high degree of confidence (90 to 95 percent) that the true failure rate is less than the certified value. In addition, criteria must be established for revoking certification when the data no longer satisfactorily assure an acceptable failure-rate level. This may be done by defining the producer's risk at a failure rate somewhat lower than the certified level. To simplify the use of the criteria, charts or tables should be incorporated into the specification.

3. OUTLINE OF FORM AND INSTRUCTIONS FOR PREPARATION OF DESIGN AND PROCUREMENT DOCUMENTATION FOR MILITARY PARTS

3.1 Introduction.

It cannot be emphasized too strongly that this section is not recommended as a replacement for all the present Department of Defense "M" manuals. Since this section does constitute an example of a system that will accomplish the purposes stated below, however, it is recommended that it be used as a guide in the much-needed revision of the "M" manuals. The purposes are:

(1) To provide a guide to documentation format for use by

(a) industrial, commercial and professional associations; and
(b) the Military Departments;

(2) To provide all information desired by

(a) the Military Departments, when "association" documentation is used by military contractors; and
(b) industrial organizations, when they use "association" or military documentation;

(3) To make possible incalculable savings in future Defense budgets.

The several "M" manuals that have been prepared by the cognizant offices of the OSD (Office of the Secretary of Defense) establish basic Department of Defense policy on preparing documentation of procurable (purchasable) items. Most of these manuals are individually well organized and complete, but the relationship of one document to another is not defined so as to protect the Military Departments sufficiently and, at the same time, provide enough information in the most economical form for industry, both users and manufacturers of other than end items.

In the fall of 1956, a survey was conducted of a large percentage of the companies supplying equipment to the Military Departments. Its purpose was to establish an estimate of the saving that might accrue if military specifications were prepared in the proper format and contained the proper information. The results indicated a potential saving among these companies in excess of $40 million per year. Actually, this estimate is only a small part of the ultimate possible economy, because it could only have been based on the elimination of effort now being expended in preparing company standards, running special qualification tests, etc.

The really big additional saving will result from the increased reliability of equipment produced from adequately defined, procured, inspected and applied piece parts and materials and from reduced maintenance costs on the completed equipment. Thus, the definition of proper format and the provision of proper information is the first step toward realizing this enormous total potential saving. The first most logical action is the standardization of documentation prepared by industrial, commercial and professional associations. This step should then be followed by the preparation of any necessary military documentation in the same format.

A review of the recommended format reveals a close similarity between the individual documents recommended and certain documents defined by Department of Defense "M" manuals. In fact, the only real differences between the recommended and the existing formats are:

(1) the definition of the relationship of the various documents,
(2) the creation of a much-needed item (part) number and
(3) the preparation of a document listing information needed for engineering reference in selecting items for application to a particular use.

Of the three, it is probable that the importance of the first has been least recognized in present Department of Defense manuals. Apparently, the existing documents have been issued, one by one, over the past years without any recognition that each is part of a system. Certainly there has been no effort to establish the system and to define the relationship of its parts. As this is felt to be an extremely important point, it is specifically covered in these proposed instructions.

New names have been assigned to most of the individual parts of the documentation, even when the definition and content remain unchanged. This was done because much of the present confusion in discussions between industry and the Military Services and among industrial firms results from differences in semantics. The selection of a name, or expression, and agreement on its definition immediately forms a basis for understanding between the participants in discussions. The name itself is not important--it can be changed. But to understand and agree on what the documents do is important.

Some associations may not be interested in all parts of this outline, but a review of the different parts will show which ones most nearly fit their individual activities. All who prepare and use this type of documentation are strongly urged to consider using the information contained in this outline and instructions as a guide to the ultimate standardization of the documentation.

During the last several months, repeated discussions with industrial and military personnel have pointed up the need for clarifying the meanings of "completeness of documentation" and "item (part) numbers." These two subjects are discussed in sections 3.1.1 and 3.1.2, which follow.

3.1.1 Completeness of Documentation: Because items covered by military and industrial specifications vary widely, it is expected that some items will not require the completeness of documentation indicated by the proposal. Complete documentation consists of the following parts:

(1) Item Requirements Sheet: Since it will always be necessary to describe or to identify an item before it can be used, an Item Requirements Sheet must be prepared for every style or type of item. The sheet may describe one item or many. (See Figures 1 and 2.)

FSC 5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

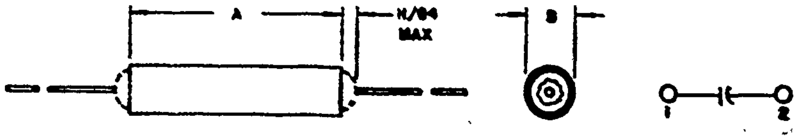

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 200 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/1
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

REVISED

APPROVED

P.A. Other Cust	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 200 v dc	ITEM REQUIREMENTS 0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 2

Figure 1

FED. SUP CLASS 5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions A +1/32 -1/16	Case Dimensions B +.015 -.005
		uf		inches	inches
0000/1-562-	M,N,O,P	.0056	K, L	13/16	.235
0000/1-682-	M,N,O,P	.0068	K, L	13/16	.235
0000/1-183-	M,N,O,P	.018	K, L	15/16	.312
0000/1-223-	M,N,O,P	.022	K, L	15/16	.312
0000/1-333-	M,N,O,P	.033	K, L	1-1/16	.312
0000/1-473-	M,N,O,P	.047	K, L	15/16	.400
0000/1-683-	M,N,O,P	.068	K, L	1-3/16	.400
0000/1-104-	M,N,O,P	.10	K, L	1-7/16	.400
0000/1-154-	M,N,O,P	.15	K, L	1-1/3	.562
0000/1-224-	M,N,O,P	.22	K, L	1-3/8	.562
0000/1-334-	M,N,O,P	.33	K, L	1-5/8	.562
0000/1-474-	M,N,O,P	.47	K, L	1-5/8	.670
0000/1-684-	M,N,O,P	.68	K, L	1-7/8	.750
0000/1-105-	M,N,O,P	1.0	K, L	2-3/8	.750

1 - Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/1 N 473 K
Failure Rate — Capacitance Tolerance

Table III - Capacitances and Dimensions

F.A. Other Cust	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 200 v dc	ITEM REQUIREMENTS 0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 2 OF 2

Figure 1 (Continued)

FED. SUP CLASS 5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

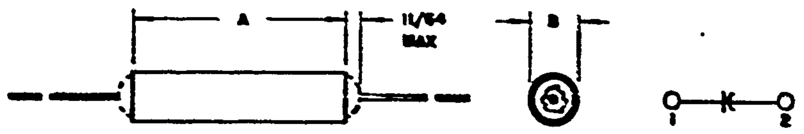

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 300 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/2
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

P.A. Other Cust	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 300 v dc	ITEM REQUIREMENTS 0000/2
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 2

Figure 2

FSC AND CLASS
5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions A $^{+1/32}_{-1/16}$	Case Dimensions B $^{+.015}_{-.005}$
		uf		inches	inches
0000/2-472-	M,N,O,P	.0047	K, L	13/16	.235
0000/2-153-	M,N,O,P	.015	K, L	15/16	.312
0000/2-223-	M,N,O,P	.022	K, L	1-1/16	.312
0000/2-333-	M,N,O,P	.033	K, L	1-1/16	.400
0000/2-473-	M,N,O,P	.047	K, L	1-5/32	.400
0000/2-683-	M,N,O,P	.068	K, L	1-13/32	.400
0000/2-104-	M,N,O,P	.100	K, L	1-1/8	.562
0000/2-154-	M,N,O,P	.15	K, L	1-3/8	.562
0000/2-224-	M,N,O,P	.22	K, L	1-5/8	.562
0000/2-334-	M,N,O,P	.33	K, L	1-3/4	.670
0000/2-474-	M,N,O,P	.47	K, L	2-1/8	.750
0000/2-684-	M,N,O,P	.68	K, L	2-3/8	.750
0000/2-105-	M,N,O,P	1.0	K, L	2-1/8	1.0

1 - Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/2 N 473 K
Failure Rate / Capacitance Tolerance

Table III - Capacitances and Dimensions

F.A.	TITLE: Capacitor, fixed, tubular, paper or paper-polyester film dielectric 300 v dc	ITEM REQUIREMENTS 0000/2
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDING	SHEET 2 OF 2

Figure 2 (Continued)

(2) Specification: Whether a separate specification will be required for every item depends on the nature of the item. It could be so simple that all requirements, including sampling and inspection, could be placed on the Item Requirements Sheet. In that case, a separate specification would not be required.

(3) Application Data Sheet: For some items, it may not be necessary to prepare Application Data Sheets if (a) no application data are necessary to ensure optimum use of the item or (b) if suitable application data already appear in another form (e.g., Mechanical Engineers Handbook, ed. Lionel S. Marks, New York: McGraw-Hill Book Company, Inc.; Military Handbook Electron Tubes Techniques for the Application of in Military Equipment, MIL-HNDBK-211, 31 December 1958). (See Figure 5.)

(4) Military Standard Sheet: Whether a Military Standard Sheet (MS)[2] is prepared, and when, depends on the following factors:

(a) Whether, in the case of Item Requirement Sheets prepared by an industrial association, it has been possible to select the specifically listed varieties of items so judiciously that the selection not only supplies all the varieties needed for immediate design but represents only those varieties that are most desirable for future new use. In these circumstances, no Military Standard Sheet shall be issued.

(b) Whether standardization (limiting) information is available at the time the Military Services issue the Item Requirements Sheet. (See section 3.2.7.)

(c) If the standardization (limiting) study is completed by the cognizant Service after the Item Requirements Sheet is released, then a Military Standard Sheet shall be issued at that time to indicate the desired limitation of items for new design. A Military Standard Sheet, if issued, shall indicate only that certain items originally described and to which part numbers were assigned on the Item Requirements Sheet shall be standard for new design.[3]

3.1.2 Item (Part) Numbers: Please note that, in this document, "item number" does not mean the same as "Federal Item Identification Number" (FIIN).

Based on a careful study of the advantages and disadvantages of both "significant" (coded) and "nonsignificant" (sequentially numbered) numbering systems, and because items covered by military and industrial specifications vary so widely, it is probable that both significant and nonsignificant item numbers will be required. (Section 3.2.6 provides for the use of both significant and nonsignificant numbers, although the examples in Figures 1 and 2 depict only the significant numbers.)

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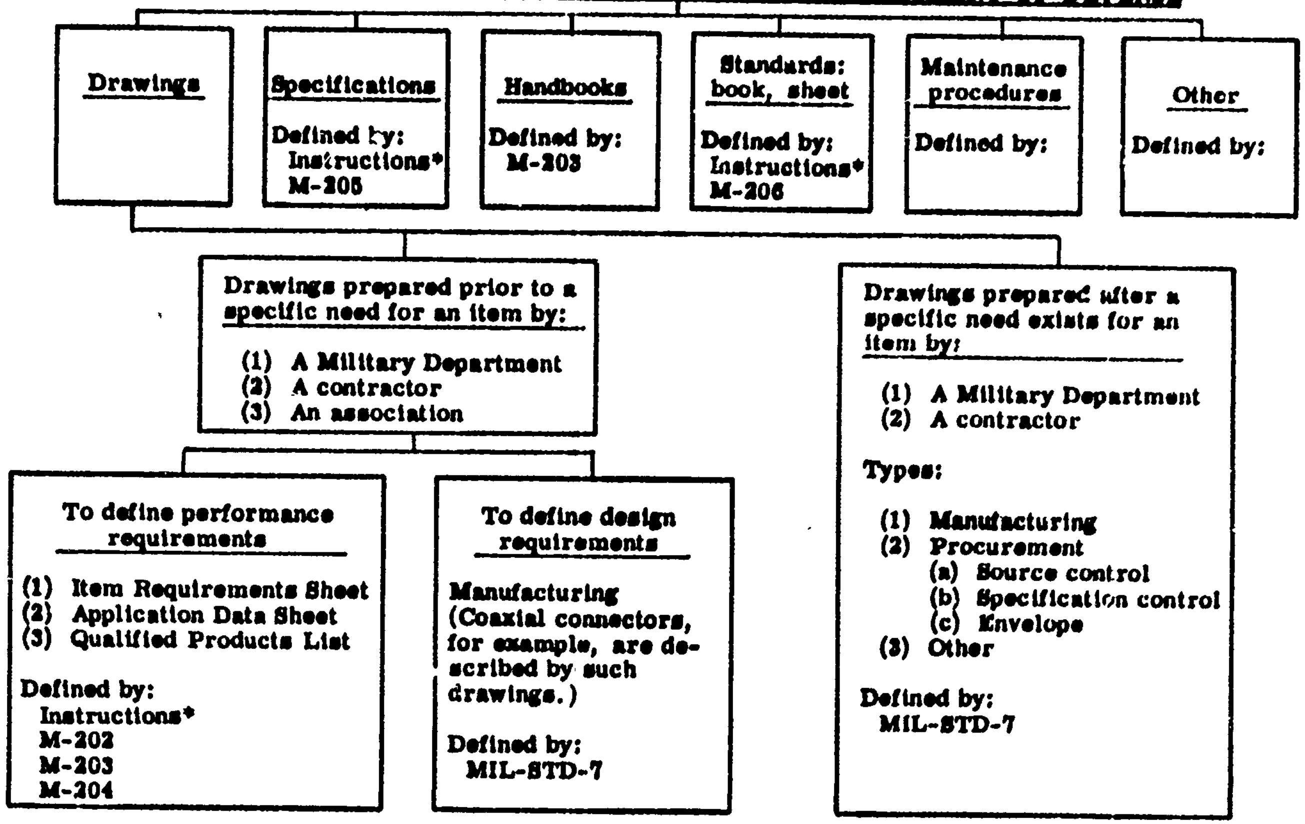
[2]Here, "MS" means a "limiting" document, not a "describing" or "identifying" one.

[3]Here, again, the MS is "limiting" and not "describing," since the item has already been described adequately on the Item Requirements Sheet.

CHART I. TECHNICAL DOCUMENTATION IN THE DEPARTMENT OF DEFENSE



NOTE: *"Outline of Form and Instructions for the Preparation of Design and Procurement Documentation for Military Components," section 3 of this document.

Both significant and nonsignificant numbers shall be prefixed by an "address" to the applicable specification. In a military specification, the address shall consist of:

(1) the numerical portion of the specification's identification,
(2) a mark to indicate a separation (/) or (-) and
(3) a number to identify the particular type or style of the item.

For example, "5757/2" for the second style of relay described by Specification MIL-R-5757; or, in the case of an NAS (National Aircraft Standard) specification, "NAS-701/2." When the complete specification requirements have been placed on the Item Requirements Sheet, a specification number shall be assigned, together with "/1," to identify the Item Requirements Sheet document number. This number shall constitute the address of individual item numbers on the sheet. The final portion of the number may be either significant or nonsignificant.

3.1.3 Relationship to Specification MIL-D-70327: Many questions have been raised recently concerning areas of apparent conflict between these instructions and the requirements of Specification MIL-D-70327, "Drawings, Engineering and Associated Lists." (It should be noted here that, if such conflicts did exist, there would also be conflicts between the "M" manuals and MIL-D-70327.) These questions arise because (1) some of the documents described here are similar to those described in MIL-D-70327, (2) the recommended numbering system differs from the system referenced by MIL-D-70327 and (3) the relationships of elements of the over-all Department of Defense system of technical documentation have not been defined.

To remove questions of conflict between these instructions (and the various "M" manuals) and MIL-D-70327, it is recommended that relationships between the various areas of technical documentation in the Department of Defense be defined as shown on Chart I.

3.2 Item Requirements Sheet.

3.2.1 Purpose: This section explains and standardizes the format in which an Item Requirements Sheet for military parts shall be prepared. The purpose of the sheet shall be to provide:

(1) A description of the item
(2) A statement of requirements for the item
(3) A technical reference for design personnel
(4) An item number

3.2.2 Definition: The Item Requirements Sheet shall present, in a simple, short, clear and accurate description, the technical requirements of items that are used repeatedly, arranged in a simple tabular form. It shall contain the following information:

(1) A paragraph referring to a specification (if applicable) as follows:

The complete requirements for procuring /item name/ described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification /number/.

(2) Design and performance (detail) requirements peculiar to the items.

(3) Reliability information, if this is a specification requirement.

(4) Complete description of item, according to the Federal Item Identification Guide.

(5) Item numbers.

(6) Document number of Item Requirements Sheet

3.2.3 Characteristics: The Item Requirements Sheet shall have the following characteristics:

(1) It shall be the primary procurement document.

(2) It shall normally be used, prior to the actual need for a specific design application, to describe a series of items which are similar, varying only in the gradation of physical sizes of electrical or mechanical values, and which may be considered suitable for many applications.

(3) It shall contain a simple drawing of the item, where feasible, together with a tabulation of its characteristics--physical dimensions, electrical and mechanical values, etc. Configuration dimensions that affect "mating" or application shall be specified with suitable tolerances.

(4) The size range or value range of the items listed shall generally be limited only by the preferential-values lists prepared and used for these items by the industry.

(5) Although the tabulation will generally include numbers for the items, on certain kinds of items the numbers may be of a coded type and so cannot be listed. In this case, information on forming them shall be given in a separate paragraph.

(6) It shall contain no requirement that is not monitored by an inspection specified either on the Item Requirements Sheet or in the referenced specification.

(7) It will normally be printed on one side of an 8x10½-inch vellum sheet so as to permit easy reproduction.

3.2.4 Format: The Item Requirements Sheet shall be in the format illustrated by Figures 1 and 2.

3.2.5 Document Number: The document number shall be composed of the applicable specification number followed by a diagonal mark (/) and a "dash" number (1, 2, 3, etc.). The dash numbers shall be assigned sequentially as new Item Requirements Sheets are prepared.

3.2.6 Item Numbers: Item numbers shall consist of the Item Requirements Sheet number plus an additional dash number. The dash number may be either a nonsignificant or a coded number, depending upon the total number and the nature of the items to be listed.

(1) Nonsignificant numbers may be assigned if the items' nature permits and if the total number of items is small enough that the assignment of nonsignificant numbers will allow all information, including the item numbers, to appear on two sheets of paper.

(2) If a coded number is required for the item, the code and the procedure for establishing the item number shall be explained in a separate paragraph. (See Figures 1 and 2.)

(3) If it can be decided which items should be "standard" at the time of issuance, then these items can be so identified by an asterisk or other symbol. In this case, no separate Military Standard Sheet ("limiting" document) need be issued for the items.

3.2.7 Use by the Military Departments: The Item Requirements Sheet shall be used by the Military Departments when they find it necessary to describe items that can be readily procured and are desirable for repeated use in their equipments, both in new-design and replacement applications.

3.3 Part Specification.

3.3.1 Purpose: This section explains and standardizes a skeleton format in which specifications for parts shall be prepared. It is not complete in itself but should be used as a guide in the revision of present Department of Defense "M" manuals.

3.3.2 Definition: A specification is a part of the documentation required to describe clearly and accurately the technical and reliability requirements for any item, including (1) prescribed methods of inspection and testing to determine that the requirements have been met and (2) requirements for packaging and packing, marking or other essential characteristics.

3.3.3 Specification: A part specification shall have a heading and shall consist of six numbered sections. It may also contain appropriate concluding material.

The titles of the sections shall be as follows:

(1) Scope
(2) Applicable Documents
(3) Requirements
(4) Quality Assurance Provisions
(5) Preparation for Delivery
(6) Notes

The subject matter shall be presented within the scope of these sections so that the same kind of requirements or information will always appear in the same section of every specification. If there is no information pertinent to a certain section, the following sentence shall appear as a numbered paragraph below the section heading:

"This section is not applicable to this specification."

The specification may also include the following concluding material, as applicable:

Appendix
Index
Supplement

3.3.4 Kind, Class and Subclass: These instructions are concerned with specifications classified as outlined in the following four subsections:

3.3.4.1 Kind: Part specifications are classified as commodity specifications. Commodity specifications are divided into three groups of progressive structural complexity--materials, products and equipment. Within these groups, part specifications are classified as product specifications.

3.3.4.2 Class: The specifications of interest here are classified as general specifications. The general specification covers requirements common to various commodities; by including requirements pertaining to a series of different types of commodities in one specification, changes in common requirements can be made rapidly and economically. The general specification bears a secondary relationship to another primary document, the Item Requirements Sheet, which contains requirements and item numbers, and it is referenced on that document.

3.3.4.3 Subclass: Specifications are classified as either performance or design specifications.

(1) Performance specifications express requirements in the form of the output, function or operation of a commodity; the details of design, fabrication and internal workings are left to the manufacturer. This type of specification should cover required performance rather than optimum performance and would ordinarily be employed when information on design details is not essential.

(2) Design specifications[4] contain all data necessary for the production of the items covered. Normally, this includes details of material, composition, physical and chemical requirements, weight, size, dimensions, etc. When feasible, design specifications incorporate design requirements by reference to design drawings. Design specifications establish the exact features of design to be used in the manufacture of a product, exactly as a production drawing establishes the features of limitations.

When other than over-all system interchangeability is affected and it is necessary to specify details of design, such as the interchangeability of minor component parts (so that the components of one manufacturer's product will be interchangeable with those of another), this method of presenting requirements may be used. The use of design specifications shall depend upon the desirability of controlling the design in all respects. They should never be used unless it is impracticable to define the requirements in a performance specification.

[4] Design specifications may include performance requirements; when such is the case, extreme care must be exercised to ensure that the design and performance requirements are compatible.

3.3.5 General Instructions on Format and Style:

3.3.5.1 Page Size and Identification: Specifications shall be printed on 8x10½-inch paper. All pages shall be numbered, and the page number shall appear at the lower right-hand margin of the odd-numbered pages and the lower left-hand margin of the even-numbered pages.

The specification number (see 3.3.5.15) shall appear on all pages at the upper right-hand margin of the odd-numbered pages and the upper left-hand margin of the even-numbered pages.

3.3.5.2 Punctuation, Spelling, etc.: The United States Government Printing Office Style Manual shall be used as a guide to punctuation, spelling, word compounding, capitalization, etc. When the information desired is not covered by the GPO Style Manual, Webster's New International Dictionary (Unabridged) shall be used.

3.3.5.3 Abbreviations and Symbols: The applicable military standard abbreviations and symbols shall be used. The only abbreviations employed shall be those in common usage and not subject to misinterpretation; and they shall be used only when they effect a genuine saving in space. Words and terms that seldom appear should not be abbreviated. The first time an abbreviation is used in text, it shall be placed in parentheses and shall be preceded by the word or term spelled out in full, e.g., pounds per square inch (psi). This rule does not apply to abbreviations used for the first time in tables and equations.

The only symbols that should be used in text are "+," "-" and "±" to express ranges or tolerances. Other symbols may be used in equations and tables.

3.3.5.4 Paragraphs: Each paragraph, or general heading for a subparagraph, shall be given a number, and these numbers shall run consecutively within each section. Each paragraph and subparagraph shall be given a heading; this helps restrict the contents to pertinent information. The same heading shall not be repeated in the main paragraphs in a section, although the use of duplicate subparagraph headings under different paragraphs may sometimes be unavoidable.

The sequence of sentences within a paragraph and of paragraphs within a section should be logical, so that the relationship of the document's parts is clear.

3.3.5.5 Cross References: Cross references can clarify the relationship of parts within the specifications and may help to avoid inconsistencies and unnecessary repetition. In referring to paragraphs within the specification, only the applicable paragraph number shall be used; the word "paragraph" shall not appear.

3.3.5.6 References to Other Documents: The reason for referring to other documents is to eliminate the repetition of requirements and tests that are adequately set forth elsewhere. While it is generally undesirable to repeat in the specification anything that appears in a referenced document, repetition is sometimes permissible if the specification is thereby clarified. For example, a requirement in a referenced document may be repeated in section 3 of a specification (provided that the excerpt is brief) in order to have a requirement corresponding to a test procedure specified in section 4 of that specification.

Since paragraph, table or figure numbers may be changed in subsequent revisions of a referenced document, descriptive terms rather than such numbers shall be used. However, test-method numbers shall be used, e.g., Standard MIL-STD-202.

Care should be taken to cover in the specification any special details called for by an applicable document. Since a self-contained specification is more usable than one requiring reference to a number of documents (which, in turn, generally refer to several more), references shall be restricted to documents that are specifically and clearly applicable to the specification.

3.3.5.7 Commonly Used Words and Phrases: With respect to certain words and phrases that are used repeatedly in all specifications, the following rules shall be observed:

(1) and/or -- The use of this phrase should be avoided.

(2) as specified in) conforming to the requirements of) in accordance with the requirements of) -- These phrases shall be used in citing applicable documents.

(3) shall) should, may) will) -- The word shall shall be used throughout the specification wherever the statement is intended to be binding on the contractor or vendor. The words should and may shall be used in statements that are not mandatory in essence. The word will shall be used in a declaration of purpose on the part of the purchaser or to state an expected result.

In negative statements, the phrase is not required shall be used instead of shall not be required.

(4) specification) drawing) bulletin, etc.) -- These words shall be capitalized only when they immediately precede the designation of the document, for example, "This specification supersedes Specification MIL-E-1001."

(5) specified in) for compliance with) -- These phrases shall be used in references to another paragraph within the specification. When a figure in the specification is referenced, the phrases shown on or specified on shall be used. For the sake of achieving uniformity and exactness throughout the specification, the word specified is generally preferable to others such as: prescribed, described, established, designated, indicated, et al.

(6) unless otherwise specified -- This phrase shall be used only when it is possible to clarify its meaning by adding in the purchase order or

herein or one or more specific paragraph numbers in the specification. When used, the phrase (and accompanying reference) shall be placed at the beginning of the sentence, if possible.

(7) In stating positive limitations, the phrase should be "The diameter shall be not greater than ...."

3.3.5.8 Tolerances: Tolerances shall be specified; except when a maximum or minimum value, or both, are considered preferable or when only an approximate value is required. The use of the symbol "±" shall be limited to the expression of tolerances from a specified value. Generally, tolerances shall be expressed in the same terms as the specified value, and they should be consistent with respect to significant figures; the reader should not be unnecessarily required to work arithmetic problems.

3.3.5.9 Definitions: The inclusion of definitions in specifications can often be avoided if the requirements are properly stated. When the meaning of one or more terms must be established in the specification, definitions shall be placed in the text where they are most useful to the reader.

3.3.5.10 Information on Contractual and Administrative Matters: Information that is generally not essential to the manufacture and testing of the commodity shall be placed in section 6 only, and it shall be restricted to what is considered really important to the user of the specification.

3.3.5.11 Figures: A figure is a picture or graph that represents a clearer and more accurate description than can otherwise be provided. When used, a figure constitutes an integral part of the requirements of a specification. (Figures should not be confused with numbered and dated drawings, which would be listed in section 2 as references only.)

Each figure should be located following, or within, the paragraph containing a reference to it. All data on a figure shall be clearly related to, and consistent with, the text of the associated paragraph. All figures shall be titled, and they shall be consecutively numbered with Arabic numerals.

3.3.5.12 Tables: A table is an orderly, concise arrangement of data in lines and columns and should be used when data can thus be presented more clearly than in text. The contents of a table should be organized and arranged to show clearly the significance and relationship of the data. Whenever possible, the basic elements to which data in other columns relate horizontally should be placed in the first column.

A table should be located following, or within, the paragraph containing a reference to it. Data included in the text of that paragraph shall not be repeated in the table, and the table's content shall be restricted to data pertinent to the associated text. Each table shall have a title indicative of its content; this helps avoid the error of including unrelated data. All tables shall be consecutively numbered with Roman numerals.

(For information on footnotes to tables, see the following paragraph 3.3.5.13.)

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3.3.5.13 Footnotes: Footnotes to the text should be used sparingly. Their purpose is to convey additional, nonessential information that is not properly a part of the specification's requirements. When such information must be included, it can often be incorporated as a paragraph in section 6 of the specification, and a reference to it can be appropriately located elsewhere if necessary.

Footnotes to text shall be consecutively numbered with Arabic numerals throughout the specification, and each shall appear on the page containing the reference to it.

Footnotes to tables may contain mandatory information that cannot be presented as data within a table. They shall be numbered separately for each table and shall be placed within the lines enclosing it.

3.3.5.14 Language Style: The paramount consideration in a specification is its technical essence, and this should be presented in language free of vague and ambiguous terms and using the simplest words and phrases that will convey the intended meaning. Stipulation of essential information shall be complete, whether by direct expository statements or reference to other documents. Consistency in terminology and organization of material will contribute to the specification's general clarity and usefulness.

3.3.5.15 Specification Number: The specification number shall be established according to the appropriate one of the two following procedures:

(1) Industry specifications: The number shall be prepared by using a distinctive group of letters, a hyphen (dash) and a sequentially assigned dash number. Examples are NAS-7, SMC-2, SAE-43.

(2) Future military specifications: The identification number shall be prepared by using "MIL-," plus the letter designating the type of commodity covered by the specification, plus the 4-digit Federal Stock Code assigned to the item covered by the specification, plus a sequentially assigned number, e.g., MIL-M-61051, to identify the first specification that would be written for "Motors, electrical," whose Federal Stock Code is 6105.

3.3.6 Heading: The specification heading consists of the following parts:

(1) Security classification
(2) Number and approval date
(3) Supersession data
(4) Title

3.3.6.1 Security Classification: If the material in a specification falls within the category of security information, as defined by Department of Defense regulations, the proper security classification shall be determined and printed in capital letters not less than one-fourth-inch high at the top and bottom of each page. In addition, the following statement shall be printed at the bottom of the first page:

> This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or

the revelation of its contents in any manner to an unauthorized person is prohibited by law.

3.3.6.2 Number and Approval Date: The number of the specification (see 3.3.5.15) shall be placed immediately below the top margin and inside the right-hand margin of the first page. The date on which the specification was approved shall be placed on the next line below, expressed as follows: day of month, month and year (e.g., 21 June 1960).

3.3.6.3 Supersession Data: When applicable, the word "SUPERSEDING" and the number(s) and date(s) of superseded specification(s) shall be placed on consecutive lines below the approval date. When more than three specifications are superseded or when a specification is superseded in part, the statement "(See section 6.)" shall be placed below the word "SUPERSEDING" and the pertinent information shall be placed in section 6.

3.3.6.4 Title: The title shall consist of the basic name of the commodity or process covered by the specification, followed by the minimum number of modifiers necessary to distinguish the specification from others on similar subjects. The item name of the commodity shall be in accordance with the Federal Item Identification Guide. The plural form shall be used if the specification covers more than one type, class, etc., of commodity or process; otherwise, the singular form is used except when the only form of the word is plural.

3.3.7 Section 1, "Scope":

3.3.7.1 General: General information concerning the applicability of the commodity or process covered by the specification--and, when necessary, its specific detailed commodity classification--shall be placed in the appropriate subdivisions of section 1. However, information properly belonging in other sections, such as detail requirements or intended use, shall not appear in section 1.

3.3.7.2 Statement of Scope: The first paragraph of section 1 shall contain a brief statement of the specification's scope; this shall consist of a clear concise abstract of the specification's coverage and may include, whenever necessary, information on the use of the product--other than specific and detailed applications, which are more properly a part of section 6. This statement shall provide a complete and comprehensive general description of the product, in terms easily interpreted by manufacturers, contractors, suppliers and others familiar with the applicable terminology and trade practices.

Specifications for items of established reliability shall define in this section the bases for the specified reliability levels, e.g., Y percent per 100 hours at X percent confidence level.

3.3.7.3 Classification: The second paragraph of section 1 shall contain classification designations; whenever practicable, those previously established should be continued. If changes are desirable, reference should be made to section 6, which should include information relating the new designations to the previous ones. The designations established in section 1 shall be used consistently throughout the specification. When only one classification is covered by the specification, this information shall be included in the first paragraph of section 1, and the classification paragraph shall be omitted.

(1) Coding: If coding is used on the applicable item requirements sheets as a part of the item numbers, it should be explained in the classification paragraph.

(2) Types, classes, grades, etc.: One or more of the classification terms defined in (a) through (f), which follow, may be used to classify the commodity. The significance of each designation used should be explained briefly in the classification paragraph.

(a) "Type" implies differences in like commodities with respect to design, model, shape, etc. Type shall be designated by Roman numerals, for example, "type I."

(b) "Class" implies differences in mechanical or other characteristics of commodities with the exception of those that constitute a difference in quality. Class shall be designated by Arabic numerals, for example, "class 1."

(c) "Grade" implies differences in quality of a commodity and shall be designated by capital letters, for example, "grade A."

(d) "Composition" shall be used to differentiate commodities that are classified by their chemical composition. The designations shall be in accordance with the applicable trade practices whenever feasible.

(e) "Style" shall be used to designate a difference in design or appearance.

(f) Other terms — If the foregoing terms do not adequately describe or classify the differences in commodities, other terms may be used, for example, color, form, weight, size, power supply, temperature rating, condition, unit, enclosure, rating, duty, insulation, kind, variety, etc.

(3) Failure rates: The specific applicable failure rates should be indicated, together with any required symbols for their designations in item numbers.

3.3.8 Section 2, "Applicable Documents": Section 2 shall contain a list of all the documents--and only those--that are referred to in sections 1, 3, 4 and 5 of the specification. References appearing on figures shall be included, but those appearing on supplementary documents, such as item requirements sheets, shall not be included. The list shall be arranged (1) by type of document (specifications, etc.), (2) by series under each type (military, etc.) and (3) by document number under each series. The sequence of listing by series shall be as follows:

Federal
Military
Air Force-Navy Aeronautical
U. S. Army
U. S. Navy
U. S. Air Force
National Bureau of Standards
Nongovernment organizations

3.3.9 Section 3, "Requirements":

3.3.9.1 General: Section 3 shall set forth all essential requirements for the physical and performance characteristics of the commodity covered by the specification. The content shall be so clearly and concisely worded as to provide a definite basis for rejection of the commodity if any requirement is not met. When both a general specification and several item requirements sheets are prepared to cover several types, classes, etc. of one commodity, the requirements applicable to all types, classes, etc., are placed in section 3 of the general specification, and the requirements applicable only to individual types, classes, etc., are placed on the individual item requirements sheets. Section 3 shall include a statement of requirements covering the information outlined in 3.3.9.2 through 3.3.9.11 (which follow), as applicable to the specification.

3.3.9.2 Detail Requirements for Individual Items: Requirements for individual items shall be placed on item requirements sheets, and the first paragraph of section 3 shall specify this as follows:

> 3.1 Detail requirements for individual /commodity/. Detail requirements (including failure-rate levels) or exceptions applicable to particular /commodity/ shall be as specified in the applicable item requirements sheet. In the event of any conflict between requirements of this specification and the item requirements sheet, the latter shall govern.

3.3.9.3 Qualification: When qualification inspections are required by section 4 of the specification, the second paragraph of section 3 shall be as follows:

> 3.2 Qualification. /Commodity/ furnished under this specification shall be a product which has been tested and has passed the qualification tests specified in /appropriate subparagraphs of section 4/.

3.3.9.4 Material: Requirements covering the materials or parts to be used in the commodity shall be presented under the heading "Material," except where it is more practicable to include the information in other paragraphs. When it is necessary to specify in detail only one material or part of the materials, the following general main paragraph may be used:

> 3./ / The material for each part shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the /commodity/ to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.3.9.5 Chemical and Physical Properties: When applicable, such properties as composition, concentration, degree of acidity or alkalinity, hardness, tensile strength, elongation, specific gravity, etc., may be specified in detail in section 3. In commodity specifications, these should be subparagraphs under "Material"; in material specifications, they should be main paragraphs with appropriate headings.

3.3.9.6 Design and Construction: General requirements for design and construction may often be covered largely by figures and tables in the general specification. Detail requirements, such as physical dimensions, tabulation of values, etc., shall be presented in individual item requirements sheets.

3.3.9.7 Measurements: Requirements with regard to dimension, capacity, size, volume, temperature, etc., shall be expressed in units according to established practice. Tolerances shall be specified where applicable and may be followed by gage number designations in parentheses.

3.3.9.8 Performance: Requirements specifying the performance expected of a commodity may be presented as separate paragraphs or as subparagraphs under the heading "Performance." Such requirements shall be supported by corresponding test procedures in section 4.

3.3.9.9 Weight, Color and Finish: When such information is required, it should be stated in separate subparagraphs under the heading "Design and Construction." The specified colors and finishes should generally be in accordance with existing standards and specifications.

3.3.9.10 Name Plates or Product Markings: In some cases, the name plate or marking may be the only means of identifying the product, which is important from the standpoint of stock, replacement and repair. All requirements pertaining to name plates or markings shall be placed under the appropriate heading, with reference to applicable specifications, drawings or standards.

3.3.9.11 Workmanship: Requirements relating to the desired standard of workmanship and to uniformity, defects and the general appearance of the finished product shall be included in a paragraph headed "Workmanship."

3.3.10 Section 4, "Quality Assurance Provisions":

3.3.10.1 General: Section 4 shall contain complete and detailed information on sampling, inspection and test of commodities presented for qualification or acceptance to determine their conformance to specified requirements. This section shall contain test procedures supporting and corresponding to the requirements stated in section 3, and whenever practicable they shall be arranged in the same order.

When other specifications or standards covering sampling, inspection or tests are referenced to make them a part of this section, any details specified by the applicable document, such as requirements for method, procedure, conditions, mounting or measurements, shall be specified. None of the referenced material should be unnecessarily repeated.

3.3.10.2 Classification of Inspections: The first paragraph in section 4 shall itemize the classifications of inspections included in the specification. The classifications "qualification inspection," "acceptance inspection" or "failure-rate inspection" shall be used, as applicable. Pertinent definitions are as follows:

(1) Inspection means the examination (including testing) of supplies and services (including, when appropriate, raw materials, components and intermediate assemblies) to determine whether the supplies and services conform to contract requirements, which include all applicable drawings, specifications and purchase descriptions.

(a) Examination is an element of inspection; it consists of the investigation (without the use of special laboratory appliances or procedures) of supplies and services to determine their conformance to those specified requirements that can be thereby determined. Examination is generally nondestructive and includes--but is not limited to--visual, auditory, olfactory, gustatory, tactile and other kinds of examination, as well as gaging, measurement and simple physical manipulation.

(b) Testing, also an element of inspection, generally consists of determining by technical means the physical and chemical properties or elements of materials and supplies, or of their components, and involves not so much personal judgment as the application of established scientific principles and procedures.

(2) Qualification inspection is the examination and testing of a product to determine whether it conforms to all qualification requirements of the specification. The objective of this inspection is normally to gain approval of the commodity as a qualified product, either on an approved sources of supply list or on a company qualified products list. If no qualification inspection is required, it shall be so stated in the first paragraph of section 4.

(3) Acceptance inspection consists of examination and testing to determine whether the commodity conforms to certain specified requirements, and this inspection serves as a basis for acceptance.

(4) Failure-rate inspection is the examination and testing of items to enable the accumulation of life-test data over an extended period of time. These data, generated from acceptance testing and an extension of those tests, are used in determining the items' specific failure rates.

3.3.10.3 Test Conditions, Equipment, Facilities, etc.: Information of this nature relating to all tests shall be specified under appropriate paragraph headings.

3.3.10.4 Qualification Inspection: The following information shall be covered under this heading, with appropriate subparagraphs: essential information concerning the number and characteristics of specimens that constitute a sample, the test data required from the manufacturer, the test routine or sequence and the basis for refusing qualification approval. A complete list of the qualification inspection examinations and tests required, as well as information on sequence, grouping, etc., shall be provided in a table; an inspection for every requirement established in section 3 shall be included. The table will also generally serve as an index to all the requirements in section 3 and the corresponding test procedures in section 4.

3.3.10.4.1 Group C, Periodic Re-evaluation Inspection: Tests performed as part of a procurement action specifically on a "time" rather than "lot" basis shall be considered periodic re-evaluation inspection. (See 3.3.10.5 for groups A and B.) These tests are intended to ascertain whether products conforming to design standards (group A) can withstand certain environmental conditions to which they may be subjected in operation. They include environmental conditioning, e.g., subjection to shock, vibration, temperature variations, etc., during or after which group A evaluations are repeated to detect any change in the product that would affect its ability to continue meeting the qualification inspection requirements.

3.3.10.5 Acceptance Inspection: When feasible, examinations and tests constituting acceptance inspection shall be broken down into groups. The grouping shall be generally based on differences in sample size needed to obtain the desired assurance of quality, the duration and destructiveness of the tests, etc. Under each group, the following information shall be organized under appropriate subparagraphs: sampling procedure, criteria for acceptance or rejection, disposition of specimens and action to be taken if the sample is rejected. Any restrictions relating to the formation of lots (types, specific characteristics, processing, etc.) shall be specified in the first subparagraph under this heading, since the information would be applicable to all groups. A table listing the required tests should be included; the test sequence may or not be important, as indicated. All examinations and tests listed under qualification inspection (3.3.10.4) shall be included in the test groups A, B and C. The performance of all three groups of tests, therefore, will automatically ensure conformance to qualification inspection requirements. (For group C tests, see 3.3.10.4.)

Group A examinations and tests are intended to detect deviations from design standards that are attributable to manufacturing error. Each examination or test in this group involves a measurement or a comparison with a design standard.

Group B tests (life) are intended to ascertain whether products that conform to design standards (group A) can satisfactorily perform their intended function throughout their expected lives. These tests specify a number of hours or cycles of functional operation, during or after which certain group A evaluations are repeated to detect any changes in the product. (The test parameters are adjusted for a suitable failure rate in accordance with section 2 of Volume II.)

3.3.10.6 Failure-Rate Inspection: This paragraph shall contain essential information concerning the maintenance of records of acceptance life tests (including the number of items tested, the number of failures and the times to failure); a provision that some percentage of the lot acceptance life tests be continued beyond the end of the acceptance testing period to a maximum length of time determined by the expected life; and instructions for the periodic computation of the probable failure rates at a high level of confidence. The specification may provide for the maintenance of charts or tables as an alternative to the computation. (The test parameters are adjusted for a suitable failure rate in accordance with section 2 of Volume II.)

3.3.10.7 Statistical Sampling Procedures: When procedures are desired for attributes sampling, Standard MIL-STD-105 may be referenced, and the acceptable quality levels shall be specified. When there is a need for life-test or failure-rate sampling, the test plans shall be based on the documents found on page 12 of this report, Volume II. Details of lot and sample sizes and the acceptance numbers may be presented in tabular form.

3.3.10.8 Methods of Examination and Test: Under this heading shall be specified all necessary details relating to examinations and tests that must be performed to determine whether the requirements stated in section 3 have been met. The first paragraph should state the visual and mechanical inspection required to determine that the item conforms with these requirements in section 3 for which a separate corresponding test procedure is not specified elsewhere in section 4, e.g., requirements relating to material, design, construction, marking and workmanship. When the sequence of testing includes "external" and "internal" inspection, this first paragraph may be broken down into subparagraphs under those headings.

Following the first paragraph, there shall be a separate paragraph corresponding to each requirement in section 3 (with the exception of those requirements for which only a visual and mechanical inspection is specified, as already stated). The wording of these related paragraphs of sections 3 and 4 shall be carefully correlated; they shall be placed in the same sequence and shall bear the same headings. When qualification and acceptance inspections call for different test procedures, it is usually better to present this information in two separate paragraphs, avoiding repetition insofar as is possible. It may be necessary to break down lengthy procedures into appropriately titled subparagraphs. Information on procedures should be only detailed enough to achieve a reasonable degree of compatibility among the various inspection activities.

3.3.11 Section 5, "Preparation for Delivery": Information relating to requirements for preserving, packaging, packing and marking the commodity for shipment shall be included under this heading. When this information is not available, the applicable one of the following paragraphs may be used here:

> The /commodity/ shall be prepared for delivery in accordance with the manufacturer's standard practice.
>
> or
>
> The /commodity/ shall be prepared for delivery in accordance with instructions contained in the contract or purchase order.

3.3.12 Section 6, "Notes": No statements of a mandatory nature shall appear in this section. When applicable, details of the commodity's intended use shall constitute the first paragraph under this heading. The second paragraph shall list the information referred to in the specification that must be called for in the purchase order, and the relevant paragraphs shall be referenced in their numerical order.

Other paragraphs of this section may contain administrative or contractual data, cautionary statements or notes on application. Definitions should be placed in the text where they are most useful to the reader (see section 3.3.5.9). If definitions are broadly applicable or of only minor concern to the reader, they may be placed in this section, "Notes."

MILITARY SPECIFICATION

CAPACITORS, FIXED, PAPER (OR PAPER-PLASTIC) DIELECTRIC, DIRECT-CURRENT, ESTABLISHED RELIABILITY (HERMETICALLY SEALED IN METALLIC CASES)

This supplement forms a part of Specification MIL-C-0000 dated 15 July 1959.

2.01 Scope. - This supplement lists the Item Requirements Sheets which reference this specification.

Item Requirements Sheets

0000/1	Capacitors, fixed, metal case, tubular	200 volt,125°C
0000/2	Capacitors, fixed, metal case, tubular	300 volt,125°C
0000/3	Capacitors, fixed, metal case, tubular	400 volt,125°C
0000/4	Capacitors, fixed, metal case, tubular	600 volt,125°C

Figure 3

FSC 5910

3.3.13 Supplement: A supplement, prepared in the format illustrated by Figure 3 and listing all the types of commodities detailed on the item requirements sheets, shall be included in each general specification.

3.4 Approved Sources of Supply for Qualified Electronic Parts List.

3.4.1 Purpose: This section explains and standardizes the format in which approved sources of supply for qualified electronic parts lists shall be prepared.

3.4.2 Content: An approved sources of supply list shall contain the names of manufacturers who have been approved to supply the items specified on the item requirements sheets.

3.4.3 Format: Approved sources of supply lists shall be prepared in the format illustrated by Figure 4.

3.4.4 Document Number: The document number of the approved sources of supply list shall consist of the document number assigned to the item requirements sheet, preceded by "SS" (e.g., SS 0000).

3.5 Application Data Sheet.

3.5.1 Purpose: This section explains and standardizes the format in which application data sheets for military parts shall be prepared. An application data sheet is a record of information on the use application of items specified on the item requirements sheets.

3.5.2 Content: An application data sheet shall contain the following information:

(1) A reference to the applicable item requirements sheet

(2) Design and performance requirements common to other similar items and needed for design selection

(3) Reliability information (indicating whether data are estimated)

(4) Information from (a) the specification and (b) other sources that aids in the proper application of items

(5) The following statement: "This document not to be used in procurement."

(6) Document number

3.5.3 Scope: The application data sheet shall generally relate to a single specific type of item.

3.5.4 Use: The application data sheet may be used to bring to the designer's attention certain characteristics that are very important (in some applications) and the resulting use limitations that are not monitored by inspections in the specification. The sheet may also be used to establish the boundary limits of tolerance structure outside which the items shall not be used.

3.5.5 Format: Application data sheets shall be prepared in the format illustrated by Figure 5.

3.5.6 Document Number: The document number of the application data sheet shall consist of the document number assigned to the item requirements sheet, preceded by "AD" (e.g., AD 0000/1).

SS 0000/1

15 September 1959

APPROVED SOURCES OF SUPPLY LIST OF

ITEMS QUALIFIED UNDER MIL-C-0000 SPECIFICATION

CAPACITOR, FIXED, TUBULAR, PAPER OR
PAPER-POLYESTER FILM DIELECTRIC

All items listed herein have been qualified under the requirements for the item as specified in the latest effective issue of the Item Requirements Sheets. Revision of this list will be issued as necessary. The listing of an item does not release the manufacturer from compliance with specified requirements.

Item Designation	Manufacturer's Designation and Item Requirements No.	Failure Rate Level Approval	Test or Qualification Reference	Manufacturer's Name & Address
200 volt, .0056 uf to 1.0 uf	0000/1-	0.1%	DNC 3341-1	ABC Capacitor Company Hussak, N. J.
300 volt, .0047 uf to 1.0 uf	0000/2-	1.0%	DNC 3341-2	NLQ Mafgrs. Corp. N. Y., N. Y.

FIGURE 4

3.6 Military Standards Sheet.

3.6.1 Purpose: This section explains and standardizes the format in which the military standards sheets shall be prepared.

3.6.2 Content: A military standards sheet shall contain only the following information:

(1) A list of item numbers selected from the applicable item requirements sheet

(2) A statement such as "The following /items/ are standard."

(3) The following statement: "This document not to be used in procurement."

(4) Document number

3.6.3 Scope: The military standards sheet shall identify those items that the Military Services' standardization studies have shown to be desirable for new design when such a study is completed at a later date than that of the issuance of the applicable item requirements sheet. The sheets shall be "limiting" and not "describing" documents.

3.6.4 Format: Military standards sheets shall be prepared in the format illustrated by Figure 6.

3.6.5 Document Number: The document number of the military standards sheet shall consist of the document number assigned to the item requirements sheet, preceded by "MS" (e.g., MS 0000/1).

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT | FSC 5910

1. General. - Information contained herein consists of (1) general requirements taken directly from Specification MIL-C-0000 and (2) application data obtained from use history. The information is applicable to capacitors described on Item Requirement Sheets No.'s 0000/1, 0000/2, 0000/3 and 0000/4. These capacitors are high-reliability, direct-current (dc), paper or paper-polyester film (polyethylene terephthalate) dielectric, fixed tubular capacitors, hermetically sealed in metallic cases.

2. Intended Use. - These capacitors are primarily intended for filter, by-pass, and blocking purposes where the alternating-current (ac) component of the impressed voltage is small with respect to the dc voltage rating. The rating given is the steady state dc voltage, or the sum of the dc voltage and the peak ac voltage, provided that the peak ac voltage does not exceed 20 percent of the rating at 60 cps, 15 percent at 125 cps, or 1 percent at 10,000 cps. These capacitors should not be used, with an expectance of highly reliable performance, where heavy transient or pulse currents are encountered.

3. Ratings. - Based on tests contained in Specification MIL-C-0000 these capacitors have ratings as follows:

Service temperature range	: -55°C through 125°C
Working voltages	: 200, 300, 400 and 600 v dc
Insulation resistance (25°C)	
a. terminal to terminal	: 0-0.6 uf: 25,000 megohms minimum; Greater than 0.6 uf: 15,000 megohms/microfarads
b. terminal to case	: greater than 10,000 megohms
Insulation resistance (125°C)	
a. terminal to terminal	: 0-0.6 uf: 250 megohms minimum; greater than 0.6 uf: 20 megohms/microfarads
b. terminal to case	: greater than 100 megohms
Dissipation factor (1,000 cps)	: less than 1 percent
Vibration (10-2000 cps at 15G)	: no opens or intermittents
Salt spray	: no harmful corrosion

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. / Other Cust	TITLE	APPLICATION DATA
	Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	AD 0000/1, /2, /3 and /4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 5

Figure 5

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FSC 5910

Shock (50 G)	:	no shorts or intermittents	
Moisture resistance	:	I.R. more than 4,000 megohms	
Acceleration (50G for 5 sec)	:	no shorts or intermittents	
Capacitance change with temperature	:	-55°C	+2% to -10%
	:	+125°C	-3% to +10%

4. Altitude Limitations. - Capacitor bushing flashover voltage limitations should be taken into consideration when designing circuits for use in guided missiles and similar high altitude applications. The curves below give typical maximum voltages which should be taken into consideration when using these capacitors in electronic equipment. From the practical standpoint, these curves indicate that it may sometimes be necessary to specify a higher working voltage capacitor in a larger diameter case in order to insure satisfactory operation of the finished equipment.

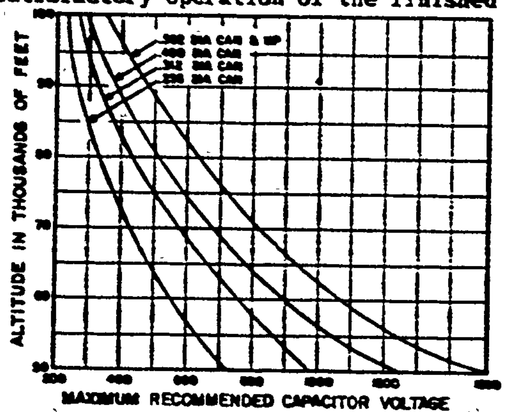

FIGURE 1

5. Mounting. - These capacitors should be mounted such that the leads are not required to withstand forces arising from the mass of the capacitor body where shock or high frequency vibration is likely to be encountered. The necessity for exercising great care in the use of a strap or clamp is emphasized. A clamp which pinches the body too tightly may injure it, either because of the stress produced in tightening or because of the aggravation of these stresses by vibration. There are available, however, clamps designed to support capacitors subject to shock and vibration.

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. / Other Cust	TITLE: Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 2 OF 5

Figure 5 (Continued)

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED. SUP CLASS 5910

The following capacitors are Standard.
(See selection note at lower left hand corner)

0000/1 N 682 L
0000/1 N 223 L
0000/1 N 473 L
0000/1 N 683 L
0000/1 N 104 L
0000/1 N 224 L
0000/1 N 474 L

REVISED

APPROVED

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors, fixed, tubular, paper or paper-polyester film dielectric 200 v dc	MILITARY STANDARD
		MS 0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 1

DD FORM 672-1

Figure 6

4. SAMPLE SPECIFICATION FOR CAPACITORS OF ESTABLISHED RELIABILITY

This section consists of a self-contained sample specification for capacitors of established reliability, together with the associated documents (item requirements sheets, etc.), prepared in accordance with the instructions set forth in section 3.

NOTE

It must be clearly recognized that this prototype specification and the item requirements sheets were prepared chiefly to exemplify the application of the basic concept to an actual specification. To do this in the time available, it was necessary to make many compromises in details which either are not pertinent to the basic objectives (e.g., details of test procedures, dimensional requirements) or, while pertinent, are a somewhat arbitrary choice (e.g., the confidence levels for acceptance tests in the capacitor specification). These details can and should be resolved in the normal processes of specification coordination. This prototype specification is not intended to be considered as a first draft of a revised specification nor to be referred to a specification group for coordination and promulgation as a new or revised military specification. Rather, it is meant to serve as an example of this new approach to specifying reliability and to guide specification-preparing activities. It must also be recognized that, since this prototype is primarily intended to illustrate principles, the application of these principles to specifications for other types of parts will necessarily call for some modification of the technical and administrative details to fit the specific item.

Furthermore, the technology of life-test sampling plans is experiencing rapid development, with continual improvement. Therefore, users of this report must bear in mind this rapidly changing technology and make use of the latest statistical techniques and improved plans.

554463 O - 60 - 4

AD HOC STUDY GROUP RECOMMENDATION
ON PROTOTYPE MILITARY SPECIFICATION

CAPACITORS, FIXED, PAPER (OR PAPER-PLASTIC) DIELECTRIC, DIRECT-CURRENT, ESTABLISHED RELIABILITY (HERMETICALLY SEALED IN METALLIC CASES)

This specification has not been approved and is not to be used for procurement purposes.

1. SCOPE

1.1 Statement of Scope. This specification covers established reliability, direct-current (dc), paper-dielectric or paper-polyester-film (polyethylene terephthalate)-dielectric, fixed capacitors hermetically sealed in metallic cases. These capacitors are primarily intended for filter, bypass, and blocking purposes where the alternating-current (ac) component of the impressed voltage is small with respect to the dc voltage rating. Capacitors covered by this specification may have a failure rate ranging from 3 percent per 1,000 hours to 0.01 percent per 1,000 hours. (See 1.2.1.2.) This failure rate is established at a 90-percent confidence level. The failure rate, identified by the applicable symbol, is referred to operation at full rated voltage at 125°C.

1.2 Classification.

1.2.1 Item number. The item number shall be in the following form and as specified (see 3.1 and 6.2):

0000/[ ]	M	104	K
Style (1.2.1.1)	Failure rate (1.2.1.2)	Capacitance (1.2.1.3)	Capacitance tolerance (1.2.1.4)

1.2.1.1 Style. The style is identified by the number assigned to the item requirements sheet that describes the particular capacitor.

1.2.1.2 Failure rate. The failure rate per 1,000 hours is identified by a single letter in accordance with Table I.

1.2.1.3 Capacitance. The nominal capacitance value expressed in micromicrofarads is identified by a 3-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. Available capacitance values are specified on the applicable item requirements sheet.

Table I. Failure rate (90-percent confidence level)

Symbol	Rate
	Percent per 1,000 hours
M	3.0
N	1.0
O	0.1
P	0.01
1/	0.001

1/ This and other failure rates can be achieved by derating. (See 6.6.)

1.2.1.4 Capacitance tolerance. The capacitance tolerance in percent is identified by a single letter in accordance with Table II.

Table II. Capacitance tolerance

Symbol	Capacitance tolerance.
	Percent
K	±10
L	±20

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

PPP-B-566	- Boxes, Folding, Paperboard.
PPP-B-575	- Box, Paper-Overlaid Veneer (Straparound Type).
PPP-B-585	- Boxes; Wood, Wirebound.
PPP-B-591	- Boxes, Fiberboard, Wood-Cleated.
PPP-B-601	- Boxes, Wood, Cleated-Plywood.
PPP-B-621	- Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636	- Boxes, Fiber
PPP-B-676	- Boxes, Set-Up, Paperboard.
PPP-T-60	- Tape; Pressure-Sensitive Adhesive, Waterproof, for Packaging and Sealing.
PPP-T-97	- Tape; Pressure-Sensitive Adhesive, Filament Reinforced.

Military

MIL-P-116	- Preservation, Methods of.
MIL-B-4229	- Boxes; Paperboard, Metal-Stayed.
MIL-B-10377	- Box, Wood, Cleated, Veneer, Paper-Overlaid.
MIL-L-10547	- Liners, Case, Waterproof.

STANDARDS

Military

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of U. S. Military Property.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

Department of Defense

Handbook H4-1 - Federal Supply Code for Manufacturers (Part I).

(Requests for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

Official Classification Committee

Uniform Freight Classification Rules.

(Requests for copies should be addressed to the Official Classification Committee, One Park Avenue, at 33rd Street, New York 16, N. Y.)

American Society for Testing Materials

D92-52 - Flash and Fire Point (Cleveland Open Cup).

(Requests for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.)

3. REQUIREMENTS

3.1 Detail requirements for individual capacitors. Detail requirements or exceptions applicable to particular capacitors shall be as specified in the applicable item requirements sheet. In the event of any conflict between requirements of this specification and the item requirements sheet, the latter shall govern. (See 6.2.)

3.2 Qualification. Capacitors furnished under this specification shall be a product that has been tested and has passed the qualification tests specified in 4.4. (See 6.3.)

3.3 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used that will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.3.1 Impregnating and filling compounds. Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor element and the case. (See 3.4.1, 6.7, and 6.8.) The compound, either in the state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitor. For liquid-filled capacitors, the same material shall be used for impregnating as is used for filling.

3.3.2 Terminal leads. Leads shall be of copper, copper alloy, or copper-clad steel. Copper alloy and copper-clad steel shall contain a minimum of 30 percent of the conductivity of electrolytic copper. Leads shall be solder-coated to facilitate soldering.

3.3.3 Terminal insulator. The terminal insulator shall be glass or ceramic.

3.3.4 Design and construction. Capacitors shall be of the design, construction, and physical dimensions specified. (See 3.1.)

3.4 Design and construction. Capacitors shall be of the design, construction, and physical dimensions specified. (See 3.1.)

3.4.1 Case. Each capacitor shall be enclosed in a hermetically sealed tin- or tin-alloy-coated brass case that will prevent leakage of the impregnant or filling compound and, in addition, will protect the capacitor element from moisture and mechanical damage under all the test conditions specified herein.

3.4.2 Capacitor element. The capacitor element shall consist of conducting layers separated by at least two layers of capacitor tissue for 200-volt-rated capacitors; for voltage ratings above 200 volts, the conducting layers shall be separated by three or more layers of capacitor tissue. Where only two layers of dielectric are used, a single layer of polyester film (polyethylene terephthalate) may be substituted for one layer of paper. Where more than two layers of dielectric are used, polyester film may be substituted for any or all of the layers, except the two outer layers adjacent to the electrodes. Extended foil construction shall be used for all capacitors.

3.5 Seal. When capacitors are tested as specified in 4.6.2, there shall be no evidence of leakage of the impregnant or filling compound.

3.6 Dielectric withstanding voltage. When capacitors are tested as specified in 4.6.3, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any evidence of visible damage.

3.7 Barometric pressure (flashover). When capacitors are tested as specified in 4.6.4, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any evidence of visible damage.

3.8 Insulation resistance.

3.8.1 Terminal-to-terminal. When measured as specified in 4.6.5, the insulation resistance shall be not less than the applicable values specified in Table

III. The value of insulation resistance varies with temperature, and it is necessary to apply a correction factor to the 25°C requirements if measurements are made at temperatures other than 25°C. Correction factors for measurements made at temperatures between the range of 20°C to 35°C are shown in Table IV. The required value of insulation resistance shall be multiplied by the correction factor to determine the new value required at the test temperature.

Table III. Terminal-to-terminal insulation resistance

Capacitance rating (microfarads)	Minimum insulation resistance (megohms)
25°C	
0 to 0.6	25,000
Greater than 0.6	15,000, divided by nominal capacitance in microfarads
125°C	
0 to 0.08	250
Greater than 0.08	20, divided by nominal capacitance in microfarads

Table IV. Insulation-resistance correction factors

Degrees centigrade	Correction factor
20	1.4
21	1.3
22	1.2
23	1.1
24	1.0
25	1.0
26	0.94
27	0.87
28	0.82
29	0.76
30	0.71
31	0.67
32	0.63
33	0.59
34	0.55
35	0.51

3.8.2 Terminal-to-case. When measured as specified in 4.6.5, the insulation resistance between any terminal and the case shall exceed 10,000 megohms.

3.9 Capacitance. When measured as specified in 4.6.6, the capacitance shall be within the tolerance shown for the item number in the item requirements sheet. (See 1.2.1.4 and 3.1.)

3.10 Dissipation factor. When measured as specified in 4.6.7, the dissipation factor shall be not more than 1.0 percent.

3.11 Vibration, high-frequency. When capacitors are tested as specified in 4.6.8, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any open- or short-circuiting or visible mechanical damage.

3.12 Temperature and immersion cycling. When tested as specified in 4.6.9, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Terminal-to-terminal - - As specified in 3.6
Terminal-to-case - - - - As specified in 3.6

Insulation resistance at 25°C:

Terminal-to-terminal - - Not less than 4,000 megohms.
Terminal-to-case - - - - Not less than 4,000 megohms.

3.13 Salt spray (corrosion). When capacitors are tested as specified in 4.6.10, there shall be no harmful corrosion, and at least 90 percent of any exposed metallic surfaces of the capacitor shall be protected by the finish. Harmful corrosion shall be construed as being any type of corrosion which in any way interferes with mechanical or electrical performance. In addition, corrosion of the terminal hardware or mounting surface shall not exceed 10 percent of the surface area. Marking shall remain legible.

3.14 Shock. When capacitors are tested as specified in 4.6.11, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any evidence of fractures or other visible mechanical damage.

3.15 Moisture resistance. When tested as specified in 4.6.12, capacitors shall meet the following requirements:

Dielectric withstanding voltage:

Terminal-to-terminal - - As specified in 3.6.
Terminal-to-case - - - - As specified in 3.6.

Insulation resistance at 25°C:

Terminal-to-terminal - - Not less than 4,000 megohms
Terminal-to-case - - - - Not less than 4,000 megohms

As a result of the test, there shall be no harmful corrosion, and at least 90 percent of any exposed metallic surfaces of the capacitor shall be protected by the finish. Harmful corrosion shall be construed as being any type of corrosion that in any way interferes with mechanical or electrical performance. Marking shall remain legible.

3.16 Acceleration. When capacitors are tested as specified in 4.6.13, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any evidence of visible mechanical damage.

3.17 Lead bend. When capacitors are tested as specified in 4.6.14, there shall be no mechanical damage to the capacitor or terminals.

3.18 Low temperature and capacitance change with temperature. When capacitors are tested as specified in 4.6.15, there shall be no indication of breakdown or arcing, nor shall there be any open- or short-circuiting or evidence of visible mechanical damage. The capacitance changes at the specified temperatures shall not exceed the limits specified in Table V.

Table V. Capacitance change at extreme temperatures

Temperature (°C)	Capacitance change (%)
-55	+2 to -10
+125	-3 to +10

3.19 Life.

3.19.1 When tested as specified in 4.6.16, capacitors shall meet the following requirements:

Insulation resistance at 25°C - Not less than 50 percent of the value specified in 3.8.1.
Capacitance ---------- Change not more than 7 percent from the initial value obtained when measured as specified in 4.6.6.
Dissipation factor ------- As specified in 3.10.

There shall be no leakage of impregnant or filling compound or deformation of the case either during or after the test.

3.19.2 Failure rate. Capacitors shall meet the requirements for one of the failure-rate levels in Table I and the applicable test requirements of 4.4 and 4.5.4 (see 6.3).

3.20 Flashpoint of impregnant or filling compound. When measured as specified in 4.6.17, the flashpoint of impregnant or filling compound shall not be lower than 145°C. This shall apply to liquid impregnants and filling compounds and to solid impregnants having a melting point of less than 145°C.

3.21 Marking. Each capacitor shall be marked, in accordance with Standard MIL-STD-130, with the item number, manufacturer's name or code, lot number, capacitance, and voltage rating. Code-designating numbers shall be in accordance with Handbook H4-1. There shall be no space between the symbols which comprise the item number. If space limitation requires it, the item number may appear on two lines. In this event, the item number shall be divided between the failure-rate and the capacitance symbols, as shown in the following example:

0000/( ) M
104K

Marking shall remain legible after all tests.

3.22 Workmanship. Capacitors shall be manufactured and processed in a careful and workmanlike manner, in accordance with good design and sound practice, and shall meet all requirements of this specification.

3.22.1 Soldering.

3.22.1.1 Flux for cleaning agents. Flux for soldering of electrical connections shall be rosin, rosin and alcohol, or rosin and turpentine. No acid nor acid salts shall be used in preparation for, or during, soldering; however, exception is permitted for preliminary tinning of electrical connections and for tinning or soldering of mechanical joints not used to complete electrical circuits, but in no case shall acid or acid salts be used where they can come in contact with insulation material. Where acid or acid salts are used, as permitted above, they shall be completely neutralized and removed immediately after use. All excess flux and solder shall be removed.

3.22.1.2 Process. There shall be no sharp points nor rough surfaces resulting from insufficient heating. The minimum necessary amount of flux and solder shall be used for electrical connections. Any means used to remove an unavoidable excess of flux shall not incur the risk of loose particles of flux, brush bristles, or other foreign material remaining in or on the capacitor; of flux being spread over a large area; or of damage to the capacitor. Insulation material that has been subjected to heating during the soldering operation shall be undamaged, and parts fastened thereto shall not have become loosened.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of inspection. The examination and testing of capacitors shall be classified as follows:

(a) Qualification inspection. (See 4.4.)
(b) Acceptance inspection. (See 4.5.)
(c) Failure-rate inspection. (See 4.5.4.)

4.1.1 Responsibility for inspection. Manufacturers are responsible for the performance of all inspections specified herein. Except as otherwise specified, manufacturers may use their own or any other laboratory facilities acceptable to the procuring activity. Records of inspection shall be kept complete and available to the procuring activity, as specified in the contract or order.

4.2 Inspection conditions. Unless otherwise specified herein, all inspection shall be made at room ambient temperature, pressure, and humidity.

4.3 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality and quantity to permit performance of the required acceptance inspection. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of the qualifying activity.

4.4 Qualification inspection.

4.4.1 Sample. The number of specimens comprising a sample of capacitors to be submitted for qualification inspection shall be 101. Specimens submitted shall be produced under conditions representative of the manufacturer's normal production. One-quarter pound of impregnating or filling compound shall be submitted.

4.4.1.1 Test facilities and quality-control procedures. The manufacturer shall submit evidence, satisfactory to the qualifying agency, of adequate test facilities and acceptable quality-control procedures to be used in production of capacitors manufactured to this specification. A detailed report listing test facilities and quality-control procedures to be utilized by the manufacturer shall be submitted to the qualifying agency. Where necessary, in order to judge the capability of the manufacturer to test and control production, the qualifying agency shall inspect the test and quality-control facilities and procedures.

4.4.1.2 Materials, design, and construction. The manufacturer shall submit a detailed description of the materials, design, and construction features of the capacitors submitted for qualification test.

4.4.2 Inspection routine. The specimens will be subjected to the examinations and tests specified in Table VI, in the order shown. Two specimens in a sample will be subjected to the visual and mechanical examination (internal). The remaining specimens will be subjected to the examinations and tests of group I. The specimens will then be divided into three remaining groups as shown in Table VI and subjected to the tests for their particular group.

4.4.3 Defectives. Defectives in excess of those allowed in Table VI will be cause for refusal to grant qualification.

4.4.4 Qualification. Granting of qualification will qualify the manufacturer for the 3-percent failure-rate level. Initial qualification will be granted for a period of 6 months. Re-evaluation of qualification will be carried out every 6 months or under any of the following conditions:

(a) The manufacturer has modified his item.
(b) The manufacturer has instituted a change in the material used or in his processing.
(c) The specification requirements for the item have been amended or revised sufficiently to affect the character of the item.
(d) On submission of:
   1. Suitable verification of a manufacturer's continued conformance to the failure rate for which qualification has been granted.
   2. Suitable verification of a manufacturer's conformance to a lower failure rate than that for which qualification has been granted.
   3. Suitable verification of a manufacturer's failure to conform to the failure rate for which qualification has been previously granted.

Table VI. Qualification inspection

Examination or test	Requirement paragraph	Method paragraph	No. of specimens to be inspected	No. of defectives allowed 1/
Group I				
Visual and mechanical examination (internal):	3.1, 3.3 to 3.4.2, incl.,	4.6.1		
Material, design, construction, and workmanship	and 3.22 to 3.22.1.2, incl.		2	0
Visual and mechanical examination (external):		4.6.1		
Physical dimensions, marking, 2/ and workmanship	3.4 and 3.21 to 3.22.1.2 incl.			
Seal	3.5	4.6.2	99	1
Dielectric withstanding voltage	3.6	4.6.3		
Barometric pressure (flashover)	3.7	4.6.4		
Insulation resistance	3.8	4.6.5		
Capacitance	3.9	4.6.6		
Dissipation factor	3.10	4.6.7		
Group II				
Vibration, high-frequency	3.11	4.6.8		
Temperature and immersion cycling	3.12	4.6.9	12	1
Salt spray (corrosion)	3.13	4.6.10		
Group III				1 3/
Shock	3.14	4.6.11		
Moisture resistance	3.15	4.6.12	12	1
Acceleration	3.16	4.6.13		
Group IV				
Lead bend	3.17	4.6.14		
Low temperature and capacitance change with temperature	3.18	4.6.15	75	1
Life	3.19	4.6.16.1		
Flashpoint of impregnant or filling compound 4/	3.20	4.6.17	--	--

1/ A specimen having one or more defects will be considered as a single defective.

2/ Marking defects are based on visual examination only and will be charged only for illegible, incomplete, or incorrect marking.

3/ No more than one failure is allowed in groups II and III combined.

4/ Two specimens will be taken from the 1/4-pound impregnant submitted.

4.4.4.1 Periodic re-evaluation inspection (group C). Tests specified in Table VII and labeled group C inspection shall be performed in the order shown. Test data obtained therefrom on the periodicity specified in 4.4.4.1.1 shall be reviewed as a part of the complete re-evaluation of qualification.

Table VII. Group C inspection

Test	Requirement paragraph	Method paragraph	Number of specimens	Allowable failures
Subgroup 1				
Vibration, high-frequency	3.11	4.6.8	12	1 (1 for subgroups 1 and 2)
Temperature and immersion cycling	3.12	4.6.9		
Salt spray (corrosion)	3.13	4.6.10		
Subgroup 2				
Shock	3.14	4.6.11	12	1
Moisture resistance	3.15	4.6.12		
Acceleration	3.16	4.6.13		
Subgroup 3				
Lead bend	3.17	4.6.14	12	1
Low temperature and capacitance change with temperature	3.18	4.6.15		

4.4.4.1.1 Sampling procedure. Twelve specimens shall be taken from production every 6 weeks for each subgroup listed in Table VII and subjected to the tests, in the order shown. The maximum and minimum case size manufactured during that 6 weeks shall be represented in the sample in at least the approximate ratio of production. Allowable failures shall be as shown in Table VII.

4.4.4.1.2 Disposition of sample units. Sample units subjected to group C inspection shall not be delivered on any contract or order.

4.4.4.1.3 Failure in group C inspection. If a sample fails to pass the group C tests, action shall be taken immediately to determine whether an accumulation of design or process changes has adversely affected the ability of capacitors from current production to meet qualification test requirements. Capacitors represented by the group C sample and all other capacitors manufactured with the same materials, processes, etc., which have not already been submitted for acceptance inspection, shall not be offered for acceptance until the cause for the failure has been determined and concurred in by the qualifying agency as not affecting the ability of the capacitors to pass the qualification test requirement.

4.5 Acceptance inspection. Acceptance inspection shall consist of groups A and B. A copy of the test data for groups A and B shall be certified by a responsible company official of the manufacturer and forwarded to the purchaser for each lot shipped.

4.5.1 Inspection lot. An inspection lot shall be as specified in Standard MIL-STD-105 and shall consist of capacitors of a single style processed from the same jumbo roll, or combination of rolls of paper, and wherever applicable from the same production lot of polyester film, impregnated in the same impregnation run, having the same voltage rating and number of dielectric layers, and having a maximum ratio of 20 to 1 between the maximum and minimum nominal capacitance values. Each lot shall be kept separate from every other lot. Test data shall be submitted by the manufacturer with each lot. All units belonging to a lot shall be identified by means of a code (either letters or numbers at the option of each manufacturer).

4.5.2 Group A inspection. Group A inspection shall consist of the tests and examinations specified in Table VIII. Except for subgroup 1, statistical sampling and inspection shall be in accordance with Standard MIL-STD-105. The tests in subgroup 1 shall be performed on each capacitor offered for acceptance. The acceptable quality levels (AQL) shall be as specified in Table VIII. Defects shall be as defined in Standard MIL-STD-105.

Table VIII. Group A inspection

Examination or test	Requirement paragraph	Method paragraph	AQL (% defective)
Subgroup 1			
Seal	3.5	4.6.2	Not applicable
Dielectric withstanding voltage	3.6	4.6.3	
Subgroup 2			
Barometric pressure (flashover)	3.7	4.6.4	0.10
Insulation resistance	3.8	4.6.5	
Capacitance	3.9	4.6.6	
Dissipation factor	3.10	4.6.7	
Subgroup 3			
Visual and mechanical examination:			1.0
Physical dimensions	3.4	4.6.1	
Marking	3.21	4.6.1	
Workmanship	3.22 to 3.22.1.2, incl.	4.6.1	

4.5.2.1 Process average. The process average, as defined in MIL-STD-105, shall be computed from the results of the group A inspection. Data pertaining to lots rejected by the group A inspection shall be included in the process average computations, regardless of the subsequent disposition of such lots.

4.5.2.2 Rejected lots. Lots rejected by the group A inspection shall be segregated from new lots and those lots that have passed inspection. Such rejected lots may be offered for acceptance only if the manufacturer inspects all units in the lot for those quality characteristics found defective in the sample and, after removing all defective units found, reinspects the lot using the tightened inspection procedure of Standard MIL-STD-105.

4.5.3 Group B inspection. Group B inspection shall consist of the test specified in Table IX.

Table IX. Group B inspection

Test	Requirement paragraph	Method paragraph
Life	3.19	4.6.16.1

4.5.3.1 Selection of sample. A sample shall be selected at random from each inspection lot that has passed group A inspection. The manufacturer may use any sample size and corresponding acceptance number shown in Table X provided that (1) the sample size is selected before the life test begins and (2) the sample size selected is in the group of sample sizes listed for the failure-rate level for which the item is certified.

Table X. Sampling for group B inspection

Sample size	Acceptance number for manufacturers certified for failure-rate level of:			
	3%(M)	1%(N)	0.1%(O)	0.01%(P)
30	0	*1/	*	*
80	1	0	*	*
114	2	1	*	*
147	3	2	0	*
300	8	6	1	0

1/* This sample size not used for the indicated failure-rate level; use a larger sample size.

4.5.3.2 Failure in group B inspection. If an inspection lot is rejected as a result of failure to pass group B inspection, the lot shall not be resubmitted to the procuring activity.

4.5.4 Failure-rate inspection.

4.5.4.1 Certification of failure-rate level. Certification of the failure-rate level applicable to a qualified capacitor shall be granted by the qualifying activity upon the manufacturer's submission of sufficient evidence that capacitors from

Table XI. Summary of life tests

Production days	Lot number	Rating (µf-vdc)	Test-starting date	Test-completion date	Lot size	Sample size	Test-duration hours	Test-unit-hours	Number of failures

current production consistently meet the failure-rate level for which certification is desired. Granting of initial qualification approval qualifies the manufacturer at the M (3 percent per 1,000 hours) level. Certification at lower failure-rate levels and retention of certification at the established failure-rate level shall be based upon accumulated data from completed life tests.

4.5.4.2 Life test records. The manufacturer shall maintain records of life tests similar to Tables XI and XII. Life tests on every production lot that has been submitted for acceptance inspection shall be included.

4.5.4.3 Extended life tests. For the purpose of failure-rate inspection, the duration of the life test on any sample, or portion of a sample, may be extended to 2,000 hours. The decision to thus extend the life test shall be made before the life test is started, at which time the scheduled test-completion date, lot number, sample size and test duration shall be entered in the record. Samples subjected to the 2,000-hour life test shall include both the smallest and largest capacitance values in each voltage rating in production. At least 20 percent--but not more than 50 percent--of the unit-hours logged in each test record shall represent units that shall have been subjected to the 2,000-hour life test.

4.5.4.4 Failure-rate charts. The manufacturer shall maintain a continuing plot of total failures versus accumulated unit-hours of test time on charts of the type shown in Figure 1. These charts indicate the maximum number of failures permitted for the unit-hours accumulated in order to obtain certification of failure-rate level (line A) and for retention of the certification of the established failure-rate level (line B). All data from consecutively completed life tests shall be included in the plot, whether the lot was accepted or rejected.

4.5.4.5 Reinitiation of data accumulation. Whenever the plot of failures versus accumulated test unit-hours crosses either line A or line B, the manufacturer shall initiate a new chart. The manufacturer may maintain two charts concurrently, one corresponding to his currently established failure rate and one corresponding to the next lower failure rate, for which certification is being sought. The criteria for reinitiating the charts shall be applied to each chart separately. In any event, new charts shall be initiated at least once each 6 months for failure rates M, N, and O and at least once each 18 months for failure rate P, or at any time when the manufacturer makes a change in the design, materials, or processes which, in the opinion of the qualifying activity, would have an appreciable effect on the failure rate of the capacitors.

4.5.4.6 Submission of test records.

4.5.4.6.1 M failure rate. The manufacturer shall submit to the qualifying activity test records (see Table XII) that are sufficient to substantiate that the failure rate does not exceed the established failure-rate level of 3 percent, not longer than 6 months after granting of qualification. Figure 1 shows minimum unit-hours and failure permissible.

4.5.4.6.2 N, O, P failure rates. When a number of test-unit-hours and associated number of failures sufficient to warrant certification at a lower established failure-rate level (see Figure 1) have been accumulated in the test record (see Table XII), the manufacturer may apply to the qualifying activity for such certification. The data submitted shall be certified by a responsible company official.

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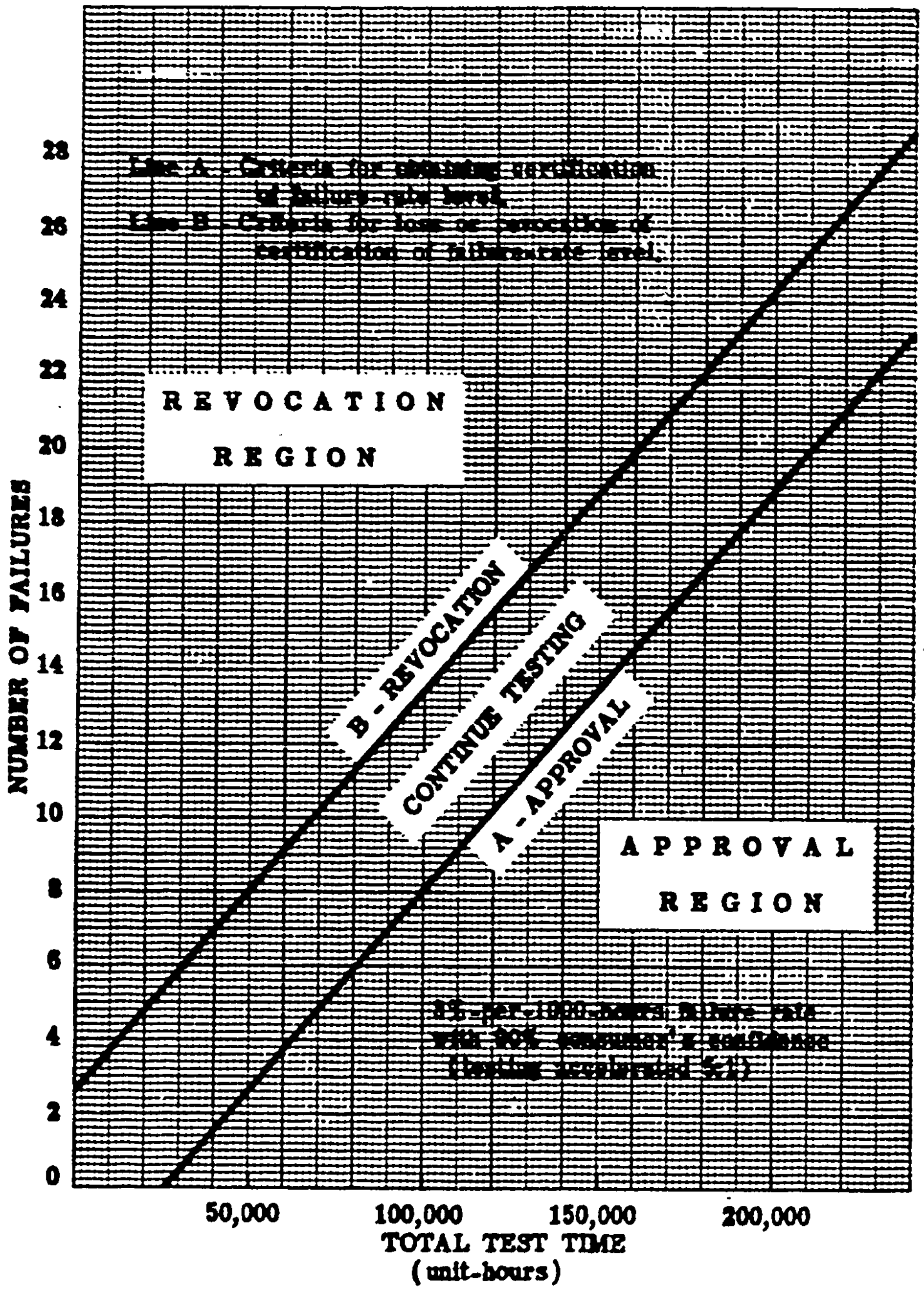

Figure 1. Determination of established failure-rate level

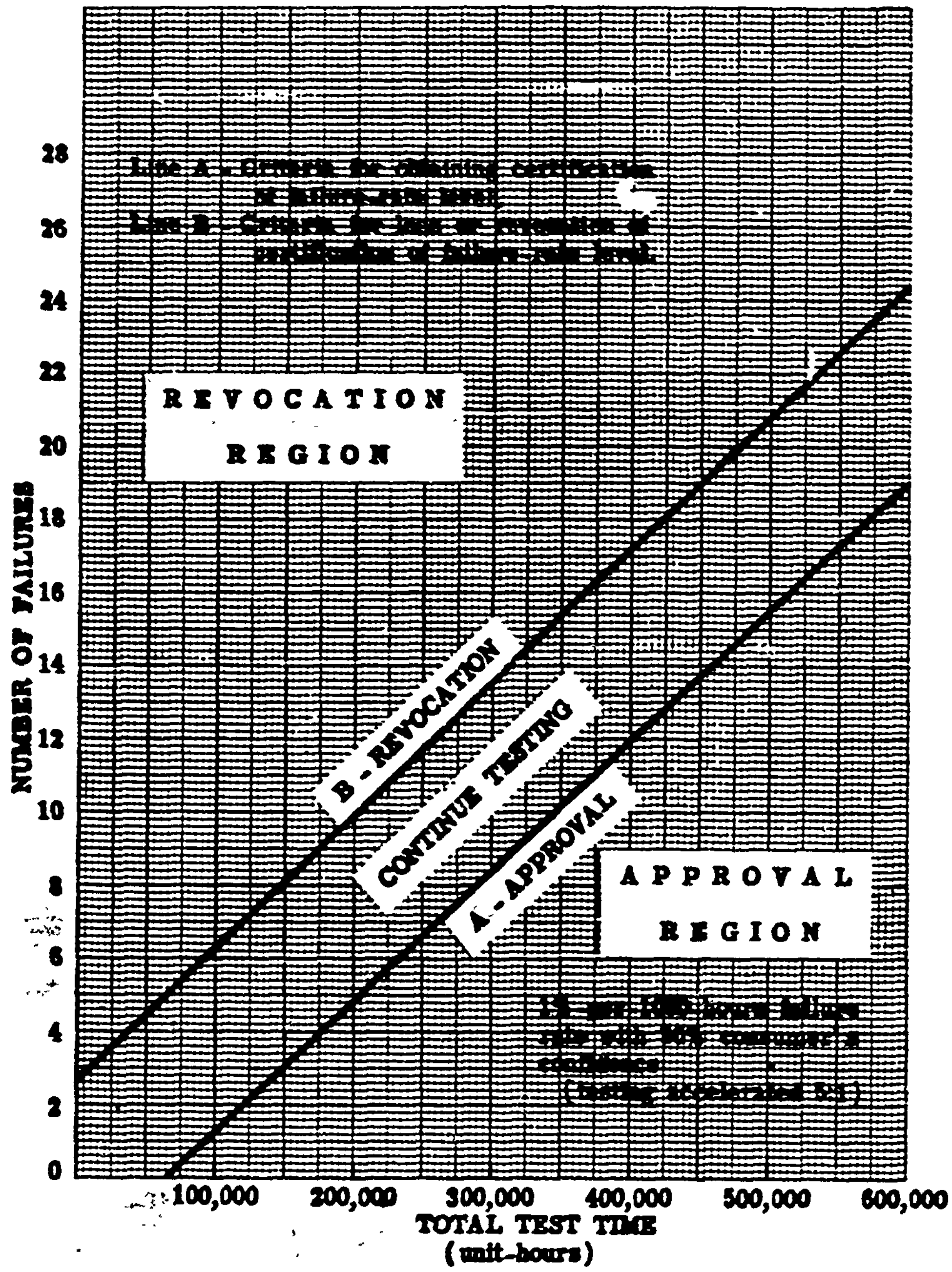

Figure 1. (continued)

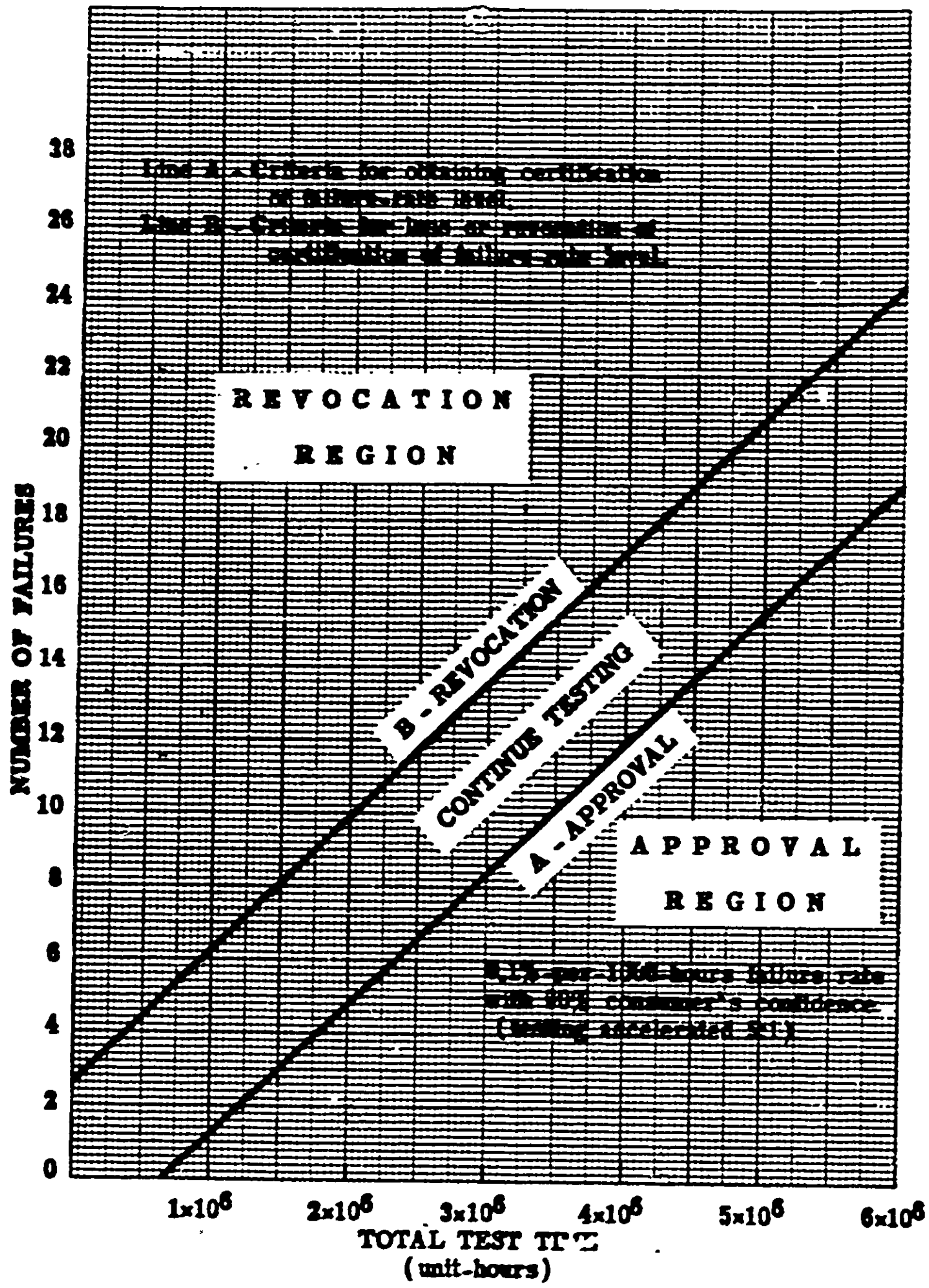

Figure 1. (continued)

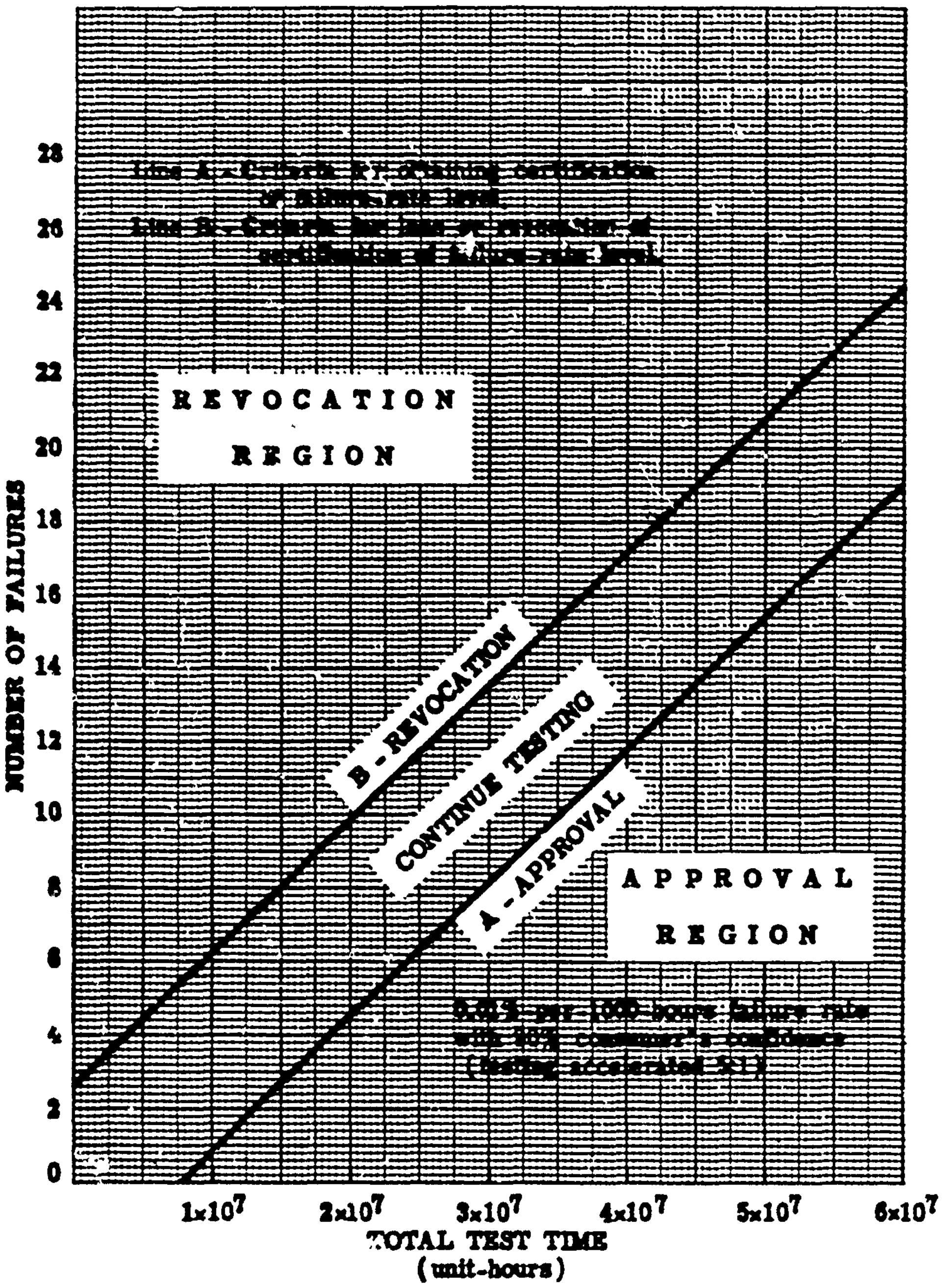

Figure 1. (continued)

Table XII. Establishment of failure rate

Lot number	Test-unit-hours	Number of failures	Summation of test-unit-hours	Summation of failures

4.5.4.6.3 Correction of failure-rate level. The established failure-rate level shall be subject to recertification at a corrected level if the number of failures recorded in the test record (see Table XII) exceeds the applicable line B for the manufacturer's established failure-rate level. The manufacturer shall notify the qualifying activity on a weekly basis whenever the summation of completed test-unit failures exceeds the applicable line B for the manufacturer's established failure-rate level. Failure to meet the manufacturer's established failure-rate level will result in corrected certification of established failure-rate level at a higher level or removal from the approved sources of supply for qualified electronic parts list.

4.5.4.6.4 Exemption of data from determination of failure-rate level. Where a life test is known to be faulty, either as a result of test-equipment failure or as a result of an error in manufacturing the lot, the test data obtained shall be entered in the test record and submitted to the qualifying activity along with a complete explanation. The qualifying activity shall then decide whether the failure shall be used in the computation of established failure rate. There shall be no doubt in the opinion of the qualifying activity that the explanation is valid, and there shall be ample technical and statistical evidence that the type of error in manufacturing or the equipment failure is unusual and not typical.

4.6 Methods of examination and test.

4.6.1 Visual and mechanical examination. Capacitors shall be inspected to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements. Conformance to the material, design, and construction features of the qualified capacitors shall be ensured by inspection of the product at whatever point in the manufacturing process is deemed to be most suitable. (See 3.1, 3.3 to 3.4.2, and 3.21 to 3.22.1.2.)

4.6.2 Seal. Capacitors shall be stabilized at room temperature prior to immersion for a minimum of 1 minute in oil maintained at a temperature of 125° ±5°C. For capacitors with a liquid impregnant, the following seal test may be substituted: Capacitors shall be placed on a clean sheet of absorbent paper and exposed to 125°±5°C for a minimum of 1 hour. Capacitors to be subjected to the temperature- and immersion-cycling and salt-spray tests may be excluded from this test until after completion of the temperature- and-immersion-cycling and salt-spray tests. (See 3.5.)

4.6.3 Dielectric withstanding voltage. Capacitors shall be tested as specified in Table XIII. The surge current shall be limited to between 5 milliamperes and 1 ampere. When necessary, a suitable current-limiting resistor shall be inserted into the circuit. At least 95 percent of the specified potential (see Table XIII) shall appear across the terminals of the capac[illegible]or prior to, and during, the period of time specified. A suitable means shall be used to detect momentary or permanent breakdown. Capacitors shall then be visually examined for evidence of damage. (See 3.6.)

Table XIII. Dielectric withstanding voltage

Circuit diagram	Test	Test connections	Test voltage 1/ (% rated dc voltage)	Time test voltage applied 2/ (minutes)
1—| |—2	Terminal-to-terminal	1 to 2	200	1
	Terminal-to-case	1 and 2 to case	200	1 3/

1/ 175 percent rated dc voltage after temperature- and immersion-cycling and moisture-resistance tests.

2/ For the subgroup 1 acceptance inspection specified in 4.5.2, the capacitors shall be subjected, at the option of the manufacturer, to the application of 250 percent of rated dc potential, for not less than 5 seconds, or 200 percent for not less than 15 seconds.

3/ For acceptance inspection, applications of potential may be made between each terminal individually and the case.

4.6.4 Barometric pressure (flashover). (See 3.7.) Capacitors shall be tested in accordance with method 105 of Standard MIL-STD-202. The following details shall apply:

(a) Mounting-- By normal mounting means.
(b) Test-condition letter -- B
(c) Test during subjection to reduced pressure -- A potential equal to 125 percent of rated dc voltage (see 3.1) shall be applied for at least 1 minute between each terminal and every other terminal in turn and between the case and each terminal not connected to the case. A suitable means shall be used to detect momentary or permanent breakdown. Capacitors shall then be visually examined for evidence of damage.

4.6.5 Insulation resistance. (See 3.8.) Capacitors shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

(a) Test potential -- A potential equal to the rated voltage (see 3.1) or 500 volts dc, whichever is less.

(b) Points of measurements:

1. Terminal-to-terminal -- Insulation resistance shall be measured between terminals at 125°±3°C, and at 25°±3°C or corrected thereto.
2. Terminal-to-case -- The measurement shall be made between each terminal and the case at 25°C.

(c) Time constant -- The time constant of the measurement circuit shall be not greater than 30 seconds.

4.6.6 Capacitance. (See 3.9.) Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details shall apply:

(a) Test frequency -- 1,000±100 cycles per second (cps).
(b) Limit of accuracy -- Shall be within ±1 percent.

4.6.7 Dissipation factor. (See 3.10.) The dissipation factor of each capacitor shall be measured at an ac voltage not greater than 20 percent of the rated dc voltage (see 3.1), at a frequency of 1,000±100 cps. Measurement accuracy shall be within ±2 percent.

4.6.8 Vibration, high-frequency. (See 3.11.) Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting -- Capacitors shall be rigidly mounted by the body to a vibration-test apparatus.
(b) Test-condition letter -- B.
(c) Direction and duration of motion -- 4 hours in each of 2 mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.
(d) Measurements during vibration -- During the last cycle in each direction, an electrical measurement shall be made to detect momentary or permanent breakdown or open circuit.
(e) Examination after vibration -- Capacitors shall be visually examined for evidence of mechanical damage.

4.6.9 Temperature and immersion cycling. (See 3.12.)

4.6.9.1 Temperature cycling. Capacitors shall be tested in accordance with method 102 of Standard MIL-STD-202. The following details and exceptions shall apply:

(a) Test-condition letter -- C, except that during step 1 capacitors shall be conditioned at $-55^{\circ}+0^{\circ}-3^{\circ}C$.
(b) Measurements before and after cycling -- Not applicable.

4.6.9.2 Immersion cycling. Within 4 to 24 hours after completion of temperature cycling, capacitors shall be tested in accordance with method 104 of Standard MIL-STD-202. The following details and exceptions shall apply:

(a) Test-condition letter -- B.
(b) Measurements after final cycle -- The dielectric withstanding voltage and insulation resistance at 25°C of all capacitors shall be measured as specified in 4.6.3 and 4.6.5, respectively.

4.6.10 Salt spray (corrosion). (See 3.13.) Capacitors shall be tested in accordance with method 101 of Standard MIL-STD-202. The following details and exceptions shall apply:

(a) Applicable salt solution -- The salt solution concentration shall be 20 percent.
(b) Test-condition letter -- B.
(c) Measurements after exposure -- Not applicable.

After this test, capacitors shall be visually examined for evidence of harmful corrosion and obliteration of marking.

4.6.11 Shock. (See 3.14.) Capacitors shall be tested in accordance with method 205 of MIL-STD-202. The following details shall apply:

(a) Test-condition letter -- C.
(b) Electrical loading during shock -- During the test, a potential of 125 percent of the rated dc working voltage (see 3.1) shall be applied between the terminals of each capacitor under test.
(c) Measurements during and after shock -- During the test, a cathode-ray oscilloscope or other comparable means shall be used as an indicating device in determining any electrical failures. After the test, capacitors shall be visually examined for evidence of breakdown, arcing, fractures, and other visible mechanical damage.

4.6.12 Moisture resistance. (See 3.15.) Capacitors shall be tested in accordance with method 102, test condition A, of Standard MIL-STD-202, except that no measurements shall be made before and after cycling. Capacitors shall then be tested in accordance with method 106 of Standard MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting -- Capacitors shall be rigidly mounted by the body except during measurements.
(b) Initial measurements -- Not applicable.
(c) Polarization voltage -- During steps 1 to 6, inclusive, a dc potential of 100 volts shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.
(d) Loading voltage -- Not applicable.
(e) Final measurements -- After the final cycle, the capacitors shall be conditioned at 25°±5°C and a relative humidity of 50±5 percent for a period of at least 22 hours but not more than 24 hours. The dielectric withstanding voltage and insulation resistance at 25°C of all capacitors shall be measured as specified in 4.6.3 and 4.6.5, respectively.

After this test, capacitors shall be visually examined for evidence of harmful corrosion and obliteration of marking.

4.6.13 Acceleration. (See 3.16.)

4.6.13.1 Mounting. Capacitors shall be rigidly mounted by the body to an acceleration-test apparatus.

4.6.13.2 Procedure. The capacitors shall then be subjected to a constant acceleration of 50 gravity units for a period of 5 seconds in each of 3 mutually perpendicular planes. The test planes shall be parallel to the cylindrical axis, perpendicular to the cylindrical axis, and perpendicular to the cylindrical axis with the capacitor rotated 90°. During the test, 125 percent of rated dc voltage (see 3.1) shall be applied between the terminals of the capacitor. During the test, a cathode-ray oscilloscope or other comparable means shall be used as an indicating device in determining any electrical failures. After the test, capacitors shall be visually examined for evidence of breakdown, arcing, and other visible mechanical damage.

4.6.14 Lead bend. Wire-lead terminals shall be bent through 90° at a point 1/4 inch from the body of the capacitor, with the radius of curvature at the bend approximately 1/32 inch. The terminals shall be clamped to within 3/64±1/64 inch of the bend. The body of the capacitor or the clamped terminal shall then be rotated about the original axis of the bent terminal through 360° in alternating directions for 5 rotations at the rate of approximately 5 seconds per rotation. (See 3.17.)

4.6.15 Low temperature and capacitance change with temperature. (See 3.18.)

4.6.15.1 Low temperature. Capacitors shall be placed in a chamber maintained at -55°±3°C, and rated dc voltage (see 3.1) shall be applied at this condition for 48±4 hours. The air within the conditioning chamber shall be circulated.

4.6.15.2 Capacitance change with temperature. At the conclusion of the test specified in 4.6.15.1, capacitance measurements shall be made as specified in 4.6.6, except that measurements shall be made at -55°±3°C, 25°±5°C, and 125° ±3°C. The -55°C measurement shall be made before the capacitors are removed from the conditioning chamber. The measurement at each temperature shall be recorded when two successive readings taken at 5-minute intervals indicate no change in capacitance. Capacitors shall then be visually examined for evidence of breakdown, arcing, and other visible mechanical damage.

4.6.16 Life. (See 3.19.)

4.6.16.1 For qualification and acceptance inspection. Capacitors shall be subjected to 140 percent of the rated dc voltage (see 3.1) at a temperature of 125° ±3°C for 250±8 hours. During the conditioning, capacitors shall be separated by a distance of not less than 1 inch. Adequate circulation of air shall be provided to prevent the temperature within 6 inches of any capacitor from departing more than ±2°C from the nominal ambient temperature of the chamber. Radiation shall not be used as a means of heating the chamber. The surge current shall be limited to between 5 milliamperes and 1 ampere. When necessary, a suitable current-limiting resistor shall be inserted into the circuit. At the conclusion of this test, the capacitors shall be returned to the inspection conditions specified in 4.2 and shall be visually examined for leakage of impregnant or filling compound and deformation of case. Insulation resistance at 25°C, capacitance, and dissipation factor shall then be measured as specified in 4.6.5, 4.6.6, and 4.6.7, respectively.

4.6.16.2 For 2,000-hour test. Capacitors that have been subjected to the 250-hour test (see 4.6.16.1) shall be tested for an additional period of 1,750 hours in accordance with 4.6.16.1.

4.6.17 Flashpoint of impregnant or filling compound. The flashpoint of impregnant or filling compound shall be measured as specified in Publication D92-52, except that the fire point and precision do not apply. The word "impregnant" shall be substituted for the word "oil" throughout the test method. (See 3.20.)

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. (See 6.2.)

5.1.1 Level A. Capacitors shall be individually protected and unit-packaged in accordance with method III of Specification MIL-P-116. Unless otherwise specified (see 6.2), 5-unit packages or a multiple thereof shall be further packaged in intermediate containers conforming to Specification PPP-B-566, PPP-B-676, or MIL-B-4229. The gross weight of the intermediate container shall not exceed 10 pounds.

5.1.2 Level C. Capacitors shall be afforded preservation and packaging in accordance with the manufacturer's normal commercial practice.

5.2 Packing. (See 6.2.)

5.2.1 Level A. Capacitors packaged as specified (see 6.2) shall be packed in overseas-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber (class 2 or 3, as specified (see 6.2)), or wood-cleated paper-overlaid boxes conforming to Specifications PPP-B-585, PPP-B-591, PPP-B-601, PPP-B-636, and MIL-B-10377, respectively, at the option of the manufacturer. Shipping containers shall have case liners conforming to Specification MIL-J-10547; the case liners shall be closed and sealed in accordance with the appendix thereto. Case liners for boxes conforming to Specification PPP-B-636 may be omitted, provided that the center and edge seams and manufacturers' joints are sealed with tape, at least 1½ inches wide, conforming to type III, class 1, of Specification PPP-T-60. Box closures and strapping shall be as specified in the applicable box specification or appendix thereto. Fiber boxes conforming to Specification PPP-B-636 may be banded with tape conforming to type IV of Specification PPP-T-97 and appendix thereto instead of steel straps. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

5.2.2 Level B. Capacitors packaged as specified (see 6.2) shall be packed in domestic-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber, or wood-cleated paper-overlaid boxes conforming to Specifications PPP-B-585, PPP-B-591, PPP-B-601, PPP-B-621, PPP-B-636, and MIL-B-10377, respectively, at the option of the manufacturer. Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

5.2.3 Level C. Capacitors packaged as specified (see 6.2) shall be packed in containers of the type, size, and kind commonly used for the purpose, in a manner that will ensure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules, or regulations of other carriers, as applicable to the mode of transportation.

5.2.4 General. Insofar as possible and practical, exterior containers shall be uniform in shape and size, shall be of the minimum cube and tare consistent with the protection required, and shall contain identical quantities of identical items.

5.3 Marking. In addition to any special marking required by the contract or order, unit packages, intermediate packages, and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129. (See 6.2.)

6. NOTES

6.1 Intended use. The capacitors covered by this specification are intended for use in any equipment where known orders of high reliability are required.

6.2 Ordering data. Procurement documents should specify the following:

(a) The complete item number and the title, number, and date of the applicable item requirements sheet. (See 1.2.1 and 3.1.)
(b) Title, number, and date of this specification.
(c) Levels of preservation and packaging and packing, and applicable marking. (See section 5.)
(d) Number of unit packages, if other than that specified in 5.1.1.
(e) Class of fiber. (See 5.2.1)

6.2.1 Indirect shipments. The packaging, packing, and marking specified in section 5 apply only to direct purchases by, or direct shipments to, the government and are not intended to apply to contracts or orders between the manufacturer and other procuring activities.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for those products that, prior to the time set for opening of bids, have been tested and approved by the qualifying activity for inclusion in the applicable approved sources of supply for qualified electronic parts list. The activity responsible for the approved sources of supply for qualified electronic parts list is /name/.

6.3.1 Failure-rate-level qualification. Where the invitation for bid specifies a failure-rate level below the M level, awards will be made only for those products that have been approved prior to the bid-opening date by the qualifying activity as meeting the failure-rate level specified in the invitation for bid.

6.4 Mounting. Capacitors covered by this specification should be mounted by a bracket or clamp, or they should be potted when vibration or shock are likely to be encountered in service.

6.5 Actual failure rate. The actual failure rate of individual lots offered for acceptance will, in general, be considerably better than the certified level, since the manufacturer must maintain a much lower average failure-rate level in order to obtain and retain certification and to ensure acceptance of a high percentage of lots tested. The relationship between average failure rate and percentage of lots accepted is given by an operating charactistic curve for the sampling plan used. Table XIV gives two points on each of the operating characteristic curves: (1) the average failure rates that must be maintained so that 19 out of 20 lots will be accepted and (2) the failure rates at which only 2 out of 10 lots will be accepted for the sampling plans given in Table IX.

Table XIV. Failure rates

Certified failure-rate level (% per 1000 hours)	Sample size	Acceptance number	Failure rate (% per 1000 hours) corresponding to acceptance of: 19 of 20 lots	2 of 10 lots
3	30	0	0.16	4.3
3	80	1	0.37	3.0
3	114	2	0.58	3.0
3	147	3	0.74	3.0
3	300	8	1.30	3.0
1	80	0	0.05	1.6
1	114	1	0.25	2.1
1	147	2	0.46	2.3
1	300	6	0.88	2.4
0.1	147	0	0.029	0.87
0.1	300	1	0.094	0.80
0.01	300	0	0.015	0.43

6.6 Life at temperatures and voltages below and above rated. The failure rates used in this specification are referred to operation at rated voltage at 125°C. The sampling plans and failure-rate determinations throughout the specification assume an acceleration factor of 5 for the life test conducted at 125°C and 140 percent of rated voltage. Lower failure rates than those for which the manufacturer has obtained certification may be achieved by operating the capacitors at lower voltage, or at lower temperatures, or both. Factors by which failure rates are to be multiplied under conditions other than maximum are shown on Figure 2.

6.7 Liquid-impregnated capacitor. A liquid-impregnated capacitor is one in which a liquid impregnant is dominantly contained within the foil-and-paper winding but does not occupy substantially all the case volume not required by the capacitor element and its connections.

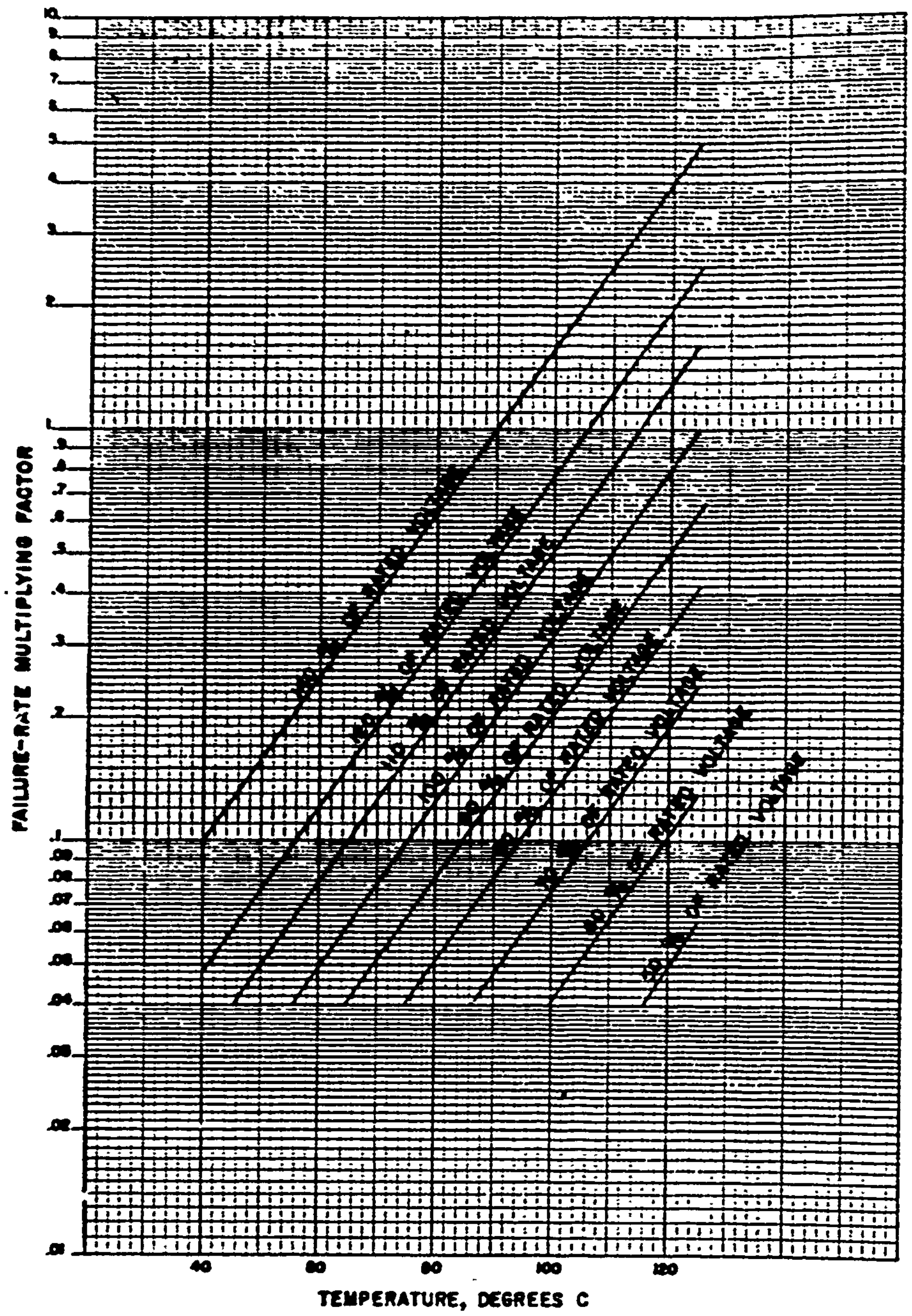

Figure 2. Life at temperatures and voltages relative to percent rating

6.8 Liquid-filled capacitor. A liquid-filled capacitor is one in which a liquid impregnant occupies substantially all the case volume not required by the capacitor element and its connections. Space may be allowed for expansion of the liquid under temperature variations.

6.9 Alternating-current component. The rating given is the steady-state dc voltage, or the sum of the dc voltage and the peak ac voltage, provided that the peak ac voltage does not exceed 20 percent of the rating at 60 cps, 15 percent at 120 cps, or 1 percent at 10,000 cps. Where heavy transient or pulse currents are encountered, the requirements of this specification are not sufficient to guarantee satisfactory performance, and due allowance must therefore be made in the selection of a capacitor.

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

MIL-C-0000
2 February 1960

MILITARY SPECIFICATION

CAPACITORS, FIXED, PAPER (OR PAPER-PLASTIC) DIELECTRIC, DIRECT-CURRENT, ESTABLISHED RELIABILITY (HERMETICALLY SEALED IN METALLIC CASES)

This supplement forms a part of Specification MIL-C-0000 dated 2 February 1960.

2.01 Scope. - This supplement lists the Item Requirements Sheets which reference this specification.

Item Requirements Sheets

0000/1 Capacitors, fixed, metal case, tubular 200 volt, 125°C

0000/2 Capacitors, fixed, metal case, tubular 300 volt, 125°C

0000/3 Capacitors, fixed, metal case, tubular 400 volt, 125°C

0000/4 Capacitors, fixed, metal case, tubular 600 volt, 125°C

FSC 5910

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FED. SUP. CLASS
5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

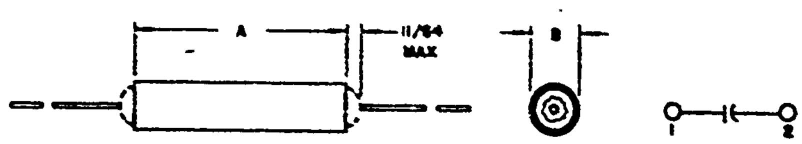

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 200 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/1
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

REVISED

APPROVED

F.A.	TITLE	ITEM REQUIREMENTS
Other Cust.	Capacitor, fixed, tubular, paper or paper-polyester film dielectric 200 v dc	0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 2

FED. SUP CLASS
5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions	
				A $^{+1/32}_{-1/16}$	B $^{+.015}_{-.005}$
		uf		inches	inches
0000/1-562-	M,N,O,P	.0056	K, L	13/16	.235
0000/1-682-	M,N,O,P	.0068	K, L	13/16	.235
0000/1-183-	M,N,O,P	.018	K, L	15/16	.312
0000/1-223-	M,N,O,P	.022	K, L	15/16	.312
0000/1-333-	M,N,O,P	.033	K, L	1-1/16	.312
0000/1-473-	M,N,O,P	.047	K, L	15/16	.400
0000/1-683-	M,N,O,P	.068	K, L	1-3/16	.400
0000/1-104-	M,N,O,P	.10	K, L	1-7/16	.400
0000/1-154-	M,N,O,P	.15	K, L	1-1/8	.562
0000/1-224-	M,N,O,P	.22	K, L	1-3/8	.562
0000/1-334-	M,N,O,P	.33	K, L	1-5/8	.562
0000/1-474-	M,N,O,P	.47	K, L	1-5/8	.670
0000/1-684-	M,N,O,P	.68	K, L	1-7/8	.750
0000/1-105-	M,N,O,P	1.0	K, L	2-3/8	.750

1 - Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/1 M 473 K
(M = Failure Rate; K = Capacitance Tolerance)

Table III - Capacitances and Dimensions

REVISED

APPROVED

F.A.	TITLE	ITEM REQUIREMENTS
	Capacitor, fixed, tubular, paper or paper-polyester film dielectric 200 v dc	0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 2 OF 2

FSC CLASS 5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

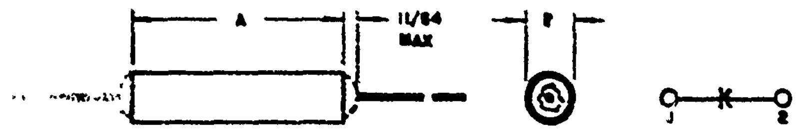

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 300 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/2
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 300 v dc	ITEM REQUIREMENTS 0000/2
PROCUREMENT SPECIFICATION MIL-C-0000		SHEET 1 OF 2

FED. SUP CLASS 5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions A $^{+1/32}_{-1/16}$	Case Dimensions B $^{+.015}_{-.005}$
		uf		inches	inches
0000/2-472-	M,N,O,P	.0047	K, L	13/16	.235
0000/2-153-	M,N,O,P	.015	K, L	15/16	.312
0000/2-223-	M,N,O,P	.022	K, L	1-1/16	.312
0000/2-333-	M,N,O,P	.033	K, L	1-1/16	.400
0000/2-473-	M,N,O,P	.047	K, L	1-5/32	.400
0000/2-683-	M,N,O,P	.068	K, L	1-13/32	.400
0000/2-104-	M,N,O,P	.100	K, L	1-1/8	.562
0000/2-154-	M,N,O,P	.15	K, L	1-3/8	.562
0000/2-224-	M,N,O,P	.22	K, L	1-5/8	.562
0000/2-334-	M,N,O,P	.33	K, L	1-3/4	.670
0000/2-474-	M,N,O,P	.47	K, L	2-1/8	.750
0000/2-684-	M,N,O,P	.68	K, L	2-3/8	.750
0000/2-105-	M,N,O,P	1.0	K, L	2-1/8	1.0

1.- Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/2 M 473 K
Failure Rate — Capacitance Tolerance

Table III - Capacitances and Dimensions

P.A. Other Cust	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 300 v dc	ITEM REQUIREMENTS 0000/2
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 2 OF 2

FSC 5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

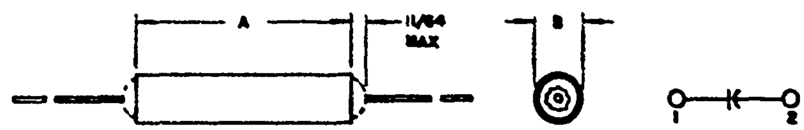

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 400 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/3
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

P.A. Other Cust	TITLE Capacitor, fixed, tubular, paper or paper-polyester film dielectric 400 v dc	ITEM REQUIREMENTS 0000/3
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 2

FED. SUP CLASS
5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions	
				A +1/32 -1/16	B +.015 -.005
		uf		inches	inches
0000/3-682-	M,N,O,P	.0068	K, L	15/16	.312
0000/3-153-	M,N,O,P	.015	K, L	1-1/6	.312
0000/3-223-	M,N,O,P	.022	K, L	15/16	.400
0000/3-333-	M,N,O,P	.033	K, L	1-1/16	.400
0000/3-473-	M,N,O,P	.047	K, L	1-5/16	.400
0000/3-683-	M,N,O,P	.068	K, L	1-9/16	.400
0000/3-104-	M,N,O,P	.10	K, L	1-1/4	.562
0000/3-154-	M,N,O,P	.15	K, L	1-1/2	.562
0000/3-224	M,N,O,P	.22	K, L	1-1/2	.670
0000/3-334-	M,N,O,P	.33	K, L	1-7/8	.670
0000/3-474-	M,N,O,P	.47	K. L	2-1/8	.750
0000/3-684-	M,N,O,P	.68	K, L	2-5/8	.750
0000/3-105-	M,N,O,P	1.0	K, L	2-1/4	1.000

1- Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/3 N 473 K
Failure Rate / Capacitance Tolerance

Table III - Capacitances and Dimensions

F.A.	TITLE	ITEM REQUIREMENTS
	Capacitor, fixed, tubular, paper or paper-polyester film dielectric 400 v dc	0000/3
MIL-C-0000		SHEET 2 OF 2

FSC 5910

The complete requirements for procurement of capacitors described hereon shall consist of all the requirements specified hereon and all the requirements specified in Specification MIL-C-0000.

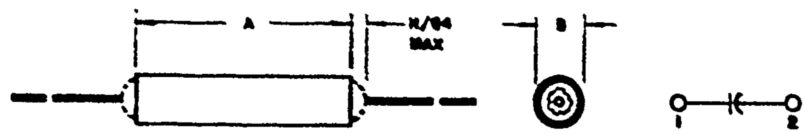

Figure 1 - Dimensions and Circuit Diagram

1. All dimensions in inches.
2. Leads shall be of solid wire, 1-5/8 $^{+1}_{-0}$ long, axially located; No. 22 AWG for cases .235 and .312 in diameter and No. 20 AWG for cases .400 through 1 in diameter.

ITEM NAME	: Capacitor, fixed, tubular
QUANTITY OF SECTIONS	: One
SECTION DATA	
Working Voltage	: 600 v dc
Capacitance Data:	
Rated Capacitance	: see Table III
Tolerance	: see Table II
Dielectric	: paper or paper-polyester film
Construction	: extended foil type
Circuit diagram	: see Figure 1
FAILURE RATE	: see Table I
STYLE	: 0000/4
CASE DATA	
Type case	: tubular metal, hermetically sealed
Dimensions	: see Table III
TERMINAL DATA	
Quantity	: two
Type	: axial wire leads
Dimensions	: see Figure 1
MOUNTING DATA	: brackets or bonding
TEMPERATURE RATING	: -55°C to +125°C

	TITLE: Capacitor, fixed, tubular, paper or paper-polyester film dielectric 600 v dc	ITEM REQUIREMENTS 0000/4
PROCUREMENT SPECIFICATION MIL-C-0000		SHEET 1 OF 2

FED. SUP CLASS 5910

Symbol	Rate
M	3.
N	1.
O	.1
P	.01

Table I - Failure Rate Percent per 1000 hours (90% confidence level)

Symbol	Tolerance
K	± 10%
L	± 20%

Table II - Capacitance Tolerance

Item Number[1]	Failure Rate	Capacitance	Capacitance Tolerance	Case Dimensions	
				$A^{+1/32}_{-1/16}$	$B^{+.015}_{-.005}$
		uf		inches	inches
0000/4-682-	M,N,O,P	.0068	K, L	1-1/16	.312
0000/4-153-	M,N,O,P	.015	K, L	1-1/16	.400
0000/4-223-	M,N,O,P	.022	K, L	1-3/16	.400
0000/4-333-	M,N,O,P	.033	K, L	1-9/16	.400
0000/4-473-	M,N,O,P	.047	K, L	1-1/8	.562
0000/4-683-	M,N,O,P	.068	K, L	1-3/8	.562
0000/4-104-	M,N,O,P	.10	K, L	1-3/4	.562
0000/4-154-	M,N,O,P	.15	K, L	1-3/4	.670
0000/4-224-	M,N,O,P	.22	K, L	1-7/8	.750
0000/4-334-	M,N,O,P	.33	K, L	2-5/8	.750
0000/4-474-	M,N,O,P	.47	K, L	2-1/8	1.0

1 - Complete Item Number will include additional symbols to indicate Failure Rate and Capacitance Tolerance -

Example: 0000/4 N 473 K
Failure Rate — Capacitance Tolerance

Table III - Capacitances and Dimensions

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P.A. Other Cust	TITLE Capacitor, fixed tubular, paper or paper-polyester film dielectric 600 v dc	ITEM REQUIREMENTS 0000/4
MIL-C-0000	SUPERSEDES	SHEET 2 OF 2

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED. SUP CLASS 5910

1. General. - Information contained herein consists of (1) general requirements taken directly from Specification MIL-C-0000 and (2) application data obtained from use history. The information is applicable to capacitors described on Item Requirement Sheets No.'s 0000/1, 0000/2, 0000/3 and 0000/4. These capacitors are high-reliability, direct-current (dc), paper or paper-polyester film (polyethylene terephthalate) dielectric, fixed tubular capacitors, hermetically sealed in metallic cases.

2. Intended Use. - These capacitors are primarily intended for filter, by-pass, and blocking purposes where the alternating-current (ac) component of the impressed voltage is small with respect to the dc voltage rating. The rating given is the steady state dc voltage, or the sum of the dc voltage and the peak ac voltage, provided that the peak ac voltage does not exceed 20 percent of the rating at 60 cps, 15 percent at 125 cps, or 1 percent at 10,000 cps. These capacitors should not be used, with an expectance of highly reliable performance, where heavy transient or pulse currents are encountered.

3. Ratings. - Based on tests contained in Specification MIL-C-0000 these capacitors have ratings as follows:

Service temperature range	: -55°C through 125°C
Working voltages	: 200, 300, 400 and 600 v dc
Insulation resistance (25°C)	
a. terminal to terminal	: 0-0.6 uf / Greater than 0.6 uf
	: 25,000 megohms minimum / 15,000 megohms/microfarads
b. terminal to case	: greater than 10,000 megohms
Insulation resistance (125°C)	
a. terminal to terminal	: 0-0.6 uf / greater than 0.6 uf
	: 250 megohms minimum / 20 megohms/microfarads
b. terminal to case	: greater than 100 megohms
Dissipation factor (1,000 cps)	: less than 1 percent
Vibration (10-2000 cps at 15G)	: no opens or intermittents
Salt spray	: no harmful corrosion

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 5

REVISED APPROVED

Shock (50 G)	: no shorts or intermittents
Moisture resistance	: I.R. more than 4,000 megohms
Acceleration (50G for 5 sec)	: no shorts or intermittents
Capacitance change with temperature	: -55°C +2% to -10%
	: +125°C -3% to +10%

4. Altitude Limitations. - Capacitor bushing flashover voltage limitations should be taken into consideration when designing circuits for use in guided missiles and similar high altitude applications. The curves below give typical maximum voltages which should be taken into consideration when using these capacitors in electronic equipment. From the practical standpoint, these curves indicate that it may sometimes be necessary to specify a higher working voltage capacitor in a larger diameter case in order to insure satisfactory operation of the finished equipment.

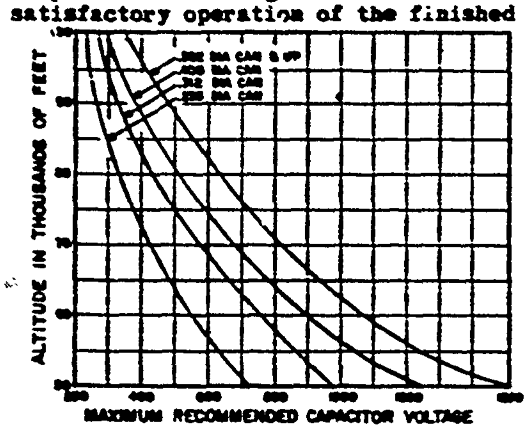

FIGURE 1

5. Mounting. - These capacitors should be mounted such that the leads are not required to withstand forces arising from the mass of the capacitor body where shock or high frequency vibration is likely to be encountered. The necessity for exercising great care in the use of a strap or clamp is emphasized. A clamp which pinches the body too tightly may injure it, either because of the stress produced in tightening or because of the aggravation of these stresses by vibration. There are available, however, clamps designed to support capacitors subject to shock and vibration.

	Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
MIL-C-0000		2 of 5

6. Stability. - Although these capacitors have a fair degree of stability, their capacitances do change with respect to time due to environments. The extent of these changes under different environmental conditions is indicated in the Item Requirements Sheet and discussed in this Application Supplement. These changes are in no way connected with or affected by the initial measured tolerance. A capacitor which is initially measured to a tolerance of ±10% can be expected to have exactly the same stability as one initially measured to a tolerance of ±20%. It will be no worse nor no better in relation to any probable drifting or aging. The only difference in the two capacitors will be that the one measured ±10% may be expected to be closer initially to the nominal capacitance value. Care should be taken, therefore, not to select capacitors of closer tolerance in order to obtain higher stability.

7. Soldering of Leads. - Care should be taken, when soldering connecting leads closer than 1/4 inch to the solder seal in the end of the capacitor, to prevent melting of the solder seal. Damage to the seal by melting can cause a leak of the impregnant, entrance of moisture into the capacitor and its ultimate breakdown.

8. Failure rate. -

a. At rated conditions. The "actual" failure rate of individual lots offered for acceptance by a given manufacturer will in general be considerably better than the failure rate for which approval has been given. This "actual" failure rate may be as low as one-fourth the rate for which approval has been granted.

b. At derated conditions. Lower failure rates than those for which approval has been granted to a given manufacturer may be achieved by operating the capacitors at lower voltage or at lower temperature or both. Factors by which approval failure rates are to be multiplied under derated conditions are given in Figure 2.

F.A. Other Cust	TITLE Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 3 OF 5

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

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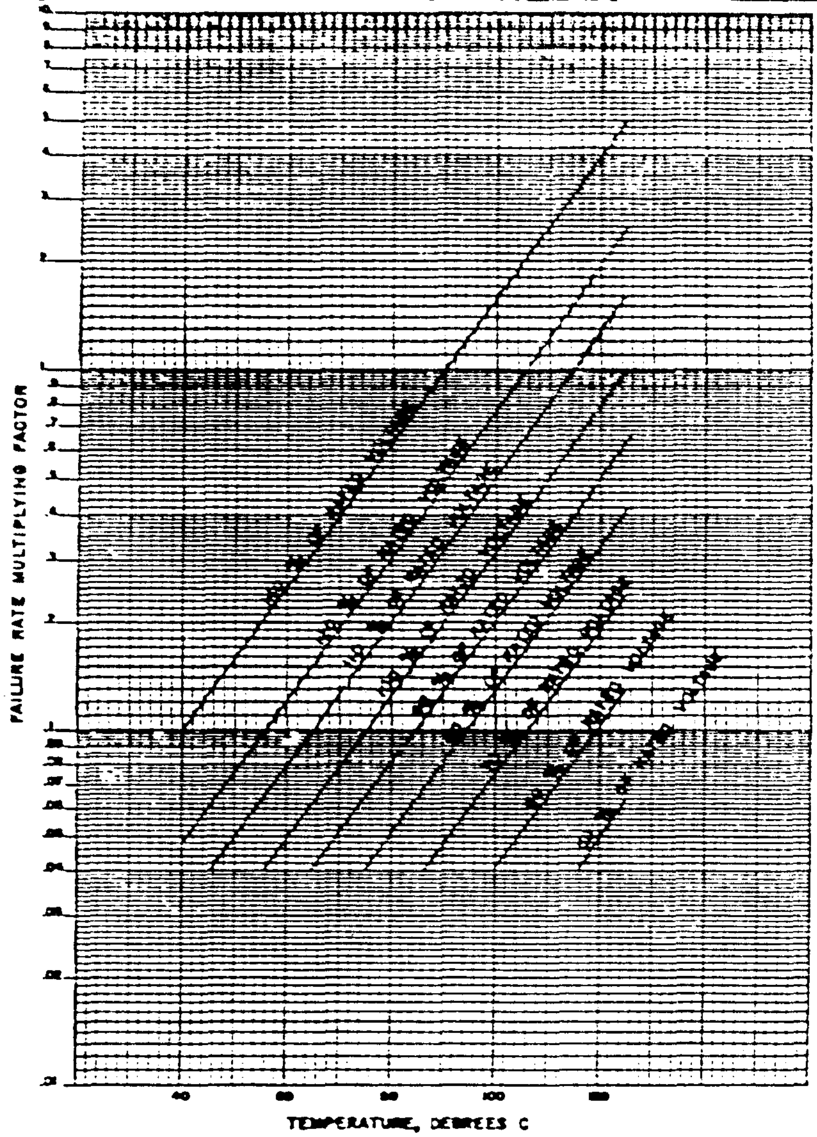

Figure 2 - Life at Temperatures and Voltages Relative to Rating

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F.A. Other Cust	TITLE Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 4 OF 5

9. Dielectric Absorption. - Dielectric absorption is defined as a certain apparent loss in charge which is not available on the capacitor plates, and which varies with dielectric material, applied voltage, charge or discharge time and temperature. The effects of dielectric absorption show most clearly on RC-timing circuits where the voltage across one, or several, capacitors has to change with time in conformance with predicted nonlinear equations. Dielectric absorption causes deviations from theoretical values and so introduces errors. Knowledge of the effects of dielectric absorption can be extremely helpful in predicting RC-timing circuit performance.

P.A.	Capacitors, fixed, tubular paper or paper-polyester film dielectric 200, 300, 400 and 600 v dc	APPLICATION DATA AD 0000/1, /2, /3 and /4
MIL-C-0000		SHEET 5 OF 5

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED. SUP CLASS 5910

The following capacitors are Standard.
(See selection note at lower left hand corner)

0000/1 N 682 L
0000/1 N 223 L
0000/1 N 473 L
0000/1 N 683 L
0000/1 N 104 L
0000/1 N 224 L
0000/1 N 474 L

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THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors,fixed,tubular,paper or paper-polyester film dielectric 200 v dc	MILITARY STANDARD MS 0000/1
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 1

DD 672-1

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THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED. SUP CLASS 5910

The following capacitors are Standard.
(See selection note at lower left hand corner)

0000/2 N 682 L
0000/2 N 223 L
0000/2 N 473 L
0000/2 N 683 L
0000/2 N 104 L
0000/2 N 224 L
0000/2 N 474 L

REVISED

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THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors, fixed, tubular, paper or paper-polyester film dielectric 300 v dc	MILITARY STANDARD
		MS 0000/2
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 1

DD FORM 672-1 (Continued)

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED. SUP CLASS 5910

The following capacitors are Standard.
(See selection note at lower left hand corner)

0000/3 N 682 L
0000/3 N 223 L
0000/3 N 473 L
0000/3 N 683 L
0000/3 N 104 L
0000/3 N 224 L
0000/3 N 474 L

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors, fixed, tubular, paper or paper-polyester film dielectric 400 v dc	MILITARY STANDARD MS 0000/3
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES:	SHEET 1 OF 1

DD FORM 672-1

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

FED SUP CLASS 5910

The following capacitors are Standard.
(See selection note at lower left hand corner)

0000/4 N 682 L
0000/4 N 223 L
0000/4 N 473 L
0000/4 N 683 L
0000/4 N 104 L
0000/4 N 224 L
0000/4 N 474 L

REVISED

APPROVED

THIS DOCUMENT NOT TO BE USED IN PROCUREMENT

P.A. Other Cust	TITLE Capacitors,fixed,tubular,paper or paper-polyester film dielectric 600 v dc	MILITARY STANDARD MS 0000/4
PROCUREMENT SPECIFICATION MIL-C-0000	SUPERSEDES	SHEET 1 OF 1

DD FORM 672-1

5. TECHNICAL BASIS FOR RELAY RELIABILITY PROVISIONS

The information in this section is presented in a form suitable for use as a guide in preparing or revising a relay specification.

* * * * *

NOTE

Your attention is invited to the note on page 43 (section 4) of this volume concerning the use of the prototype specifications and life-test sampling plans.

A general-purpose relay is an excellent example of a type of part whose reliability is a function of the number of discrete events, such as operations, rather than hours of operation. The failure rate of relays should be expressed in percent in 10,000 operations to be consistent with those recommended for time-dependent parts. From a knowledge of expected system operation, the designer can then convert relay failure rates to a time base for each relay application.

In order to limit the size of the sample and the duration of the test, the qualification inspection life test is based on 100,000 operations with no failures in a sample of 15 relays. This test provides a 77.5-percent confidence that the failure rate is not greater than 1 percent in 10,000 operations. An operating characteristic curve for this test gives a 55-percent probability that a relay with an actual failure rate of 0.4 percent in 10,000 operations will pass the test.

For a general-purpose relay that is essentially in continuous production, the acceptance inspection lot is taken as a week's production. The selection of a 100,000-operation life test permits the completion of the test in a week. To limit sample size and the test facilities required, a sequential test plan should be selected. Based on a consumer's risk of 10 percent that the failure rate will exceed 1 percent in 10,000 operations and a producer's risk of 5 percent that a lot with a failure rate of 0.4 percent in 10,000 operations will be rejected, the sample size is determined as 38 relays. Figure 1 represents the test plan, with "reject" and "accept" lines. In order to provide a certain minimum risk to the consumer and to prevent the retaining of three lots before a decision, line A is included in the "no decision" area. A lot test falling between the accept line and line A guarantees that the consumer has only a 10-percent risk of receiving a lot with a failure rate as high as 1.53 percent for 10,000 operations. If the test plot should fall between line A and the reject line, all lots should be retained until a decision is reached. At the completion of testing four lots without a decision, all unshipped lots shall be accepted if there are 9 or fewer failures and rejected if there are 10 or more failures.

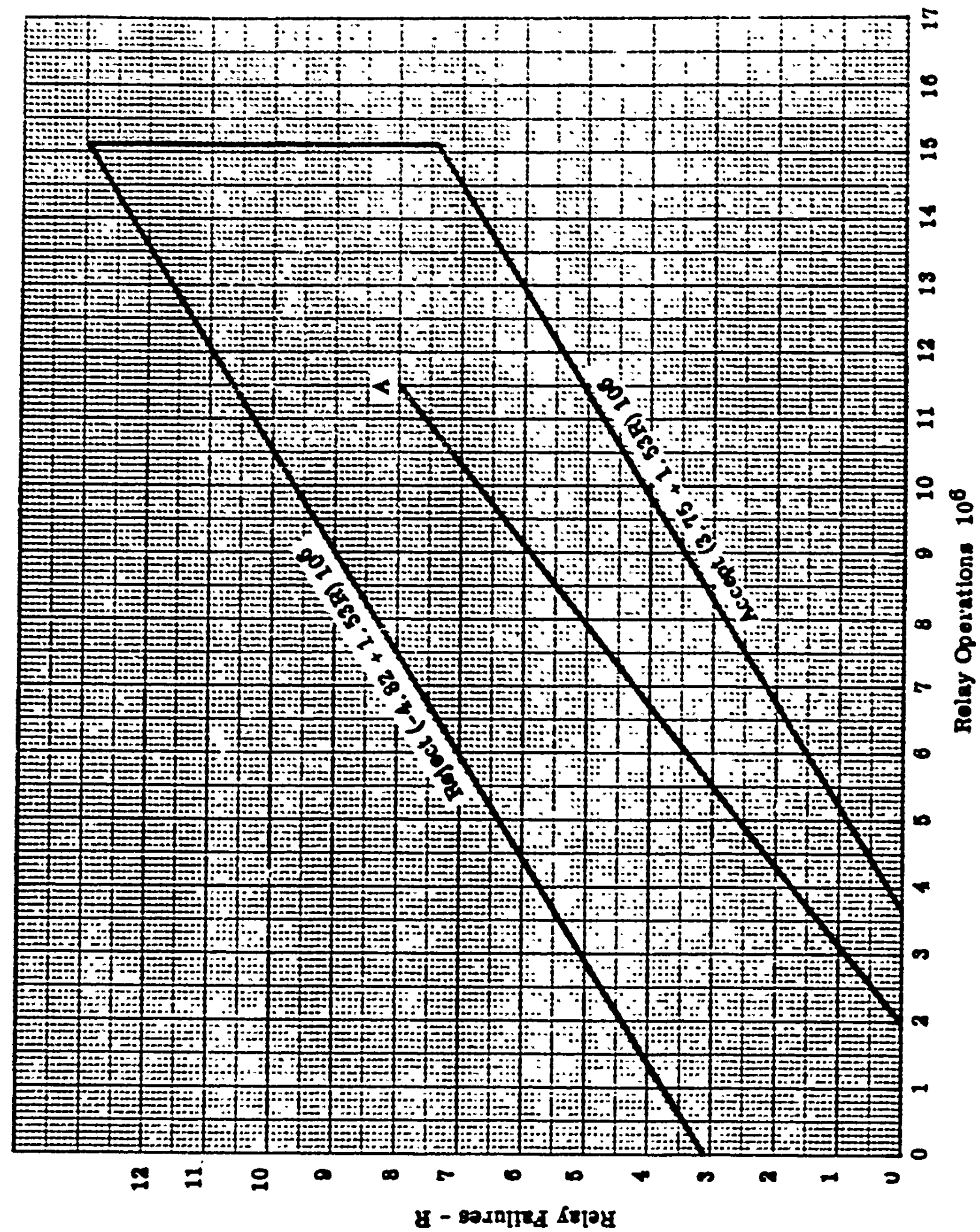

Figure 1. Life Test Acceptance Plan

10,000 operations, the manufacturer should have the option of establishing a failure rate of 0.01 percent in 10,000 operations, based on the data of six consecutive failure-rate-inspection tests and the included acceptance-inspection life tests. Having been certified for a failure rate of 0.01 percent in 10,000 operations, the manufacturer should have the option of establishing a rate of 0.001 percent in 10,000 operations by submitting each acceptance-inspection sample to the failure-rate-inspection life test. Based on the data from 70 consecutive tests, a rate of 0.001 percent in 10,000 operations can be established with a 90-percent confidence.

Provisions should be included for recertification after initial certification at the completion of each failure-rate-inspection life test, based on the previous 3, 6 or 70 tests. Failure to meet the manufacturer's established failure rate should result in corrected certification at a higher level or removal from the approved sources of supply for qualified electronic parts list.

During all life tests, relays should be monitored for gross malfunction. Life requirements on relay characteristics should be measured at intermediate points during the test. For computing failure rates, failures detected by the intermediate-point measurements shall be assumed to have occurred halfway between consecutive measurement points.

The lack of sufficient test data prevents the establishment of derating curves. Accelerated testing based on contact currents or operating at higher frequency rates is highly controversial and should not be included until definitive test data are available.

Guide for Revision of General-Purpose
Relay Specification MIL-R-5757C

Specific paragraphs are recommended for inclusion in the sections on requirements and quality-assurance provisions of Specification MIL-R-5757C for general-purpose relays assumed to be in essentially continuous production. The following "Life" paragraph should be included in the requirements section.

3.18 Life. During the test, specified relays shall show no indication of mechanical resonance due to the frequency of the energizing voltage applied to the coil. Before and after the life test, the dielectric strength, insulation resistance, contact resistance, pickup and dropout voltage (or current), contact bounce, and dc coil resistance shall be as specified.

The quality-assurance provisions should include the following:

4.1 Classification of inspection. The examination and testing of relays shall be classified as follows:

(a) Qualification inspection
(b) Acceptance inspection
(c) Failure-rate inspection

4.1.1 Responsibility for inspection. Manufacturers are responsible for the performance of all inspections specified herein. Except as otherwise specified, manufacturers may use their own or any other laboratory facilities acceptable to the procuring activity. Records of inspection shall be kept complete and available to the procuring activity, as specified in the contract or order.

4.2 Inspection conditions. Unless otherwise specified herein, all inspections shall be made at room ambient temperature, pressure, and humidity.

4.3 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of the qualifying activity.

4.4 Qualification inspection.

4.4.1 Sample. The sample submitted shall be produced under conditions representative of the manufacturer's normal production conditions. /Number/ relays of each type for which qualification is sought shall be submitted and shall be considered a sample.

4.4.2 Inspection routine. The specimens will be subjected to the examinations and tests specified in Table VI in the order shown. All specimens will be subjected to the examinations and tests of group I. The specimens will then be divided into the remaining groups, as shown in Table VI, and shall be subjected to the examinations and tests for their particular group.

Table VI. Qualification inspection

Examination or test	Requirement paragraph	Method paragraph
Group I (all specimens)		
Group II (/No._7 specimens)		
Group III (/No._7 specimens)		
Group IV (15 specimens)		
High and low temperature		
Life	3.18	4.6.15.1
Terminal strength		
Sealing		

4.4.3 Life failures. No failures are permitted in test group IV. Failure of an individual relay in one or more tests of a test group will be considered as a single failure.

4.4.4 Qualification. Granting of qualification will qualify the manufacturer for a failure-rate level of 1 percent for 10,000 operations.

4.5.1 Acceptance inspection. Acceptance inspection shall consist of groups A and B. A copy of the test data for groups A and B shall be certified by a responsible company official of the manufacturer and forwarded to the purchaser for each lot shipped.

4.5.1.1 Inspection lot. An inspection lot shall consist of relays of a single style assembled during the week.

4.5.1.2 Group B inspection. Group B inspection shall consist of the test specified in Table VIII.

Table VIII. Group B inspection

Test	Requirement paragraph	Method paragraph
Life	3.18	4.6.15.2

4.5.1.3 Selection of sample. For group B inspection, the sample shall consist of 35 relays selected randomly from the week's production.

4.5.2 Failure-rate inspection. Established failure-rate level shall be based upon data from completed life tests. Life tests on every production lot that has been submitted for acceptance inspection shall be included. Failure rates shall be computed at the 90-percent confidence level, with certification at 1, 0.1, 0.01, and 0.001 percent per 10,000 operations.

4.6 Methods of examination and test.

4.6.15 Life.

4.6.15.1 Qualification and inspection. All contacts of the relays shall be subjected to the operating voltage specified at rated contact load for 100,000 operations at a rate of 20 to 24 cycles per minute. On and off periods shall be approximately the same. Circuits shall simulate normal application characteristics insofar as practicable with respect to impedance of the voltage source and surges produced in relay coils. This test and the measurements (see 3.18) shall be conducted at the maximum temperature of the applicable range. Intermediate measurements of dielectric strength, contact resistance, and pickup and dropout voltage (or current) shall be made at intervals of 25,000 ±5,000 operations. The relays shall be monitored for gross malfunction, and failures detected at the measurement interval shall be assumed to have failed at the midpoint operation between measurements.

4.6.15.2 Acceptance inspection. The life test shall be conducted as specified in 4.6.15.1. The sequential test plan of Figure /1/ shall be used for acceptance. Each lot shall be retained until completion of its test. For the test plot falling into the no-decision area between the accept and reject lines of Figure /1/, the lot may be shipped if the plot falls between the accept line and line A. If four samples are tested without a decision, all unshipped lots shall be accepted if there are 9 or fewer failures and rejected if there are 10 or more failures.

4.6.15.3 Failure-rate inspection. In order to establish failure-rate levels of 1, 0.1, and 0.01 percent in 10,000 operations, at least 1 of every 10 acceptance-inspection samples shall be randomly selected for additional testing of 900,000 operations. The test and measurements shall be conducted at the maximum temperature of the applicable range, with measurements (see 3.18) at increments of 100,000 ±15,000 operations. In order to establish a failure-rate level of 0.001 percent in 10,000 operations, each acceptance-inspection sample shall be subjected to an additional test of 900,000 operations after the completion of the acceptance-inspection life test.

4.6.15.4 Certification. At the completion of three failure-rate-inspection life tests, the manufacturer shall submit test records to the qualifying agency to substantiate that the failure rate does not exceed the established level of 1 percent or 0.1 percent in 10,000 operations based on the 90-percent confidence-limit computation. Having been certified for a failure rate of 0.1 percent in 10,000 operations, the manufacturer shall have the option of establishing a level of 0.01 percent in 10,000 operations, based on six consecutive failure-rate-inspection life tests. Having been certified for a failure rate of 0.01 percent in 10,000 operations, the manufacturer shall have the option of establishing a failure rate of 0.001 percent in 10,000 operations, based on 70 consecutive failure-rate-inspection life tests, as specified in 4.6.15.3.

4.6.15.5 Correction of failure-rate level. The established failure-rate level after initial certification shall be subject to recertification at a corrected level on completion of each failure-rate-inspection life test, if the computed failure rate for the previous 3, 6, or 70 tests exceeds the respective established rates. Failure to meet the manufacturer's established failure-rate level will result in corrected certification of established failure-rate level at a higher level or removal from the approved sources of supply for qualified electronic parts list.

6. ELECTRON-TUBE SPECIFICATION SHEETS

The information on electron-tube specification sheets presented in this section is not offered as an example of desirable format but is intended primarily to indicate, with the least possible confusion, the procedure for adding reliability requirements.

NOTE

Your attention is invited to the note on page 43 (section 4) of this volume concerning the use of prototype specifications (in this case, the electron-tube specification sheets included herein) and life-test sampling plans.

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SAMPLE I

MIL-E-1/
30 July 1959

MILITARY SPECIFICATION SHEET
ELECTRON TUBE, RECEIVING, TWIN TRIODE, MINIATURE
JAN-5814A-3

This specification covers highly reliable receiving type electron tubes and includes test requirements necessary to assure a maximum specified failure rate when used within the high reliability ratings. (See note 22.)

This specification sheet forms a part of the latest issue of Military Specification MIL-E-1.

Description: Twin Triode, Medium Mu, Reliable.

RATINGS:	Ef V	Eb Vdc	Ec Vdc	Ehk v	Rg/g Meg	Ib/k mAdc	Ic/g mAdc	Pp/p W	T Envelope °C	Alt. ft
High Reliability Design										
Maximum:	12.6 6.3	250	0	50	0.1 Note 1	18.0	2.0	1.8	130	60,000
Minimum:	12.0 6.0	---	-50	---	---	---	---	---	---	---
Normal Design										
Maximum:	13.8 6.9	330	0	100	0.5 Note 1	20	5.0	2.7	+165	60,000
Minimum:	11.4 5.7	---	-50	---	---	---	---	---	---	---
Test Cond.:	12.6	250	-8.5	0	---	---	---	---	---	---

Cathode: Coated Unipotential
Base: Miniature Button 9-pin

Diameter: 7/8 in. max.
Height: 2 - 3/16 in. max.

Pin No.: 1 2 3 4 5 6 7 8 9
Element: 2p 2g 2k h h 1p 1g 1k hct

Envelope: T-6 1/2

The following tests shall be performed:
For the purposes of inspection, see applicable reliable paragraphs of MIL-E-1. For miscellaneous requirements, see Paragraph 3.5 in MIL-E-1 headed "Performance."

Ref.	Test	Conditions:	AQL (%)	Insp. Level or Code	Sym.	LIMITS, Note 2 Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Qualification Approval Tests											
3.1	Qualification Approval:	Required for JAN Marking	---	---								
---	Cathode:	Coated Unipotential	---	---								
3.4.3	Base Connections:		---	---								
4.9.20.3	Vibration(1):	Rp=2000; Note 3	---		Ep:	---	---	---	---	100	---	mVac
	Measurements Acceptance Test Part 1 Notes 4 and 29											
4.10.8	Heater Current:		---	---	If:	---	169	175	181	---	13	mA
4.10.8	Heater Current:		0.4	II	If:	160	---	---	---	190	---	mA
4.10.15	Heater Cathode Leakage: Note 5	Ehk = + 100 Vdc	0.4	II	Ihk:	---	---	---	---	7	---	µAdc
		Ehk = - 100 Vdc			Ihk:	---	---	---	---	7	---	µAdc
4.10.6.1	Grid Current:	Rg/g=0.1Meg; Note 5	0.4	II	Ic:	0	---	---	---	-0.5	---	µAdc
4.10.4.1	Plate Current (1):	Note 5	---	---	Ib:	---	9.0	10.5	12.0	---	3.5	mAdc
4.10.4.1	Plate Current(1):	Note 5	0.4	II	Ib:	6.5	---	---	---	14.5	---	mAdc
4.10.4.1	Plate Current (2):	Ec=-30Vdc; Rp= 0.1 Meg; Note 6	0.4	II	Ib:	---	---	---	---	20	---	µAdc
4.10.9	Transconductance(1):	Note 5	---	---	Sm:	---	2000	2200	2400	---	450	µmhos
4.10.9	Transconductance(1):	Note 5	0.4	II	Sm:	1750	---	---	---	2650	---	µmhos

FSC 5960

Ref.	Test	Conditions	AQL (%)	Insp. Level or Code	Sym.	LIMITS, Note 2 Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Measurements Acceptance Test Part 1 Notes 4 and 29 (Cont'd)											
---	Continuity and Short: (Inoperatives)	Note 7	0.4	II		---	---	---	---	---	---	
4.9.1	Mechanical:	Envelope Outline No. 6-7	---	---		---	---	---	---	---	---	
	Measurements Acceptance Test Part 2. Note 29											
4.8.2	Insulation of Electrodes: Note 3	g-all = -100 Vdc p-all = -300 Vdc	2.5	L6	R: R:	1000 1000	--- ---	--- ---	--- ---	--- ---	--- ---	Meg Meg
4.10.4.1	Plate Current(1) Difference Between Sections:		2.5	I	Ib:	---	---	---	---	3.5	---	mAdc
4.10.4.1	Plate Current(3):	Ec=-18Vdc; Note 9	2.5	I	Ib:	5	---	---	---	---	---	µAdc
4.10.9	Transconductance(2):	Ef =11.4V; Notes 5, 8	2.5	I	ΔSm: Ef	---	---	---	---	15	---	%
4.10.6.1	Grid Emission:	Ef=15V; Ec=-30 Vdc; Rg/g= 0.5Meg; Notes 5, 9	2.5	I	Ic:	0	---	---	---	-1.5	---	µAdc
4.10.3.1	RF Noise:	Ecal=7.0mVac; Ec=-9Vdc; Notes 3, 10	2.5	I		---	---	---	---	---	---	
4.10.3.5	Noise and Microphonics:	Ef=12.6 V; Ebb=300Vdc; Ec=0; Ecal=50mVac; Rk= 1500; Ck=1000µf min; Rp= 50,000; Rg=0; Notes 3, 11	2.5	I		---	---	---	---	---	---	
4.10.11.1	Amplification Factor:	Note 5	---	---	Mu:	---	16.2	17.8	17.8	---	1.8	
4.10.11.1	Amplification Factor:	Note 5	2.5	I	Mu:	15.5	---	---	---	18.5	---	
---	Pulse Cathode Current:	Ec1=-40Vdc; Notes 5, 12	2.5	Code H	Ik:	280	---	---	---	---	---	ma
4.10.9	Transconductance(3):	Eb=100Vdc; Ec=0; Note 5	6.5	Code I	Sm:	2500	---	---	---	4000	---	µmhos
4.10.14	Capacitance:	No Shield; Note 5 No Shield; Note 5 No Shield; No Shield;	6.5	Code E	Cgp: Cin: Cout 1: Cout 2:	1.20 1.25 0.30 0.20	--- --- --- ---	--- --- --- ---	--- --- --- ---	1.80 1.95 0.70 0.60	--- --- --- ---	µµf µµf µµf µµf
4.9.12.1	Low Pressure Voltage Breakdown:	Pressure=55±5mm Hg.; Voltage = 500Vac	6.5	Note 13		---	---	---	---	---	---	
4.9.19.1	Vibration(2):	Rp=2000; G=10; F=40cps; Note 3	6.5	Code I	Ep:	---	---	---	---	100	---	mVac

Ref.	Test	Conditions	AQL (%)	Insp Level or Code	Sym.	LIMITS, Note 2 Min.	LAL	Begin	EAL	Max.	ALD	Units
	Degradation Rate Acceptance Tests Notes 14 and 29											
4.9.20.5	Shock:	Hammer angle = 30°; Ehk = +100Vdc; Note 15	---	---		---	---	---	---	---	---	
4.9.20.6	Fatigue:	G=2.5; Fixed frequency; F=25 min., 60 max.	6.5	Note 13		---	---	---	---	---	---	
---	Post Shock and Fatigue Test End Points:	Vibration(2)	---	---	Ep:	---	---	---	---	150	---	mVac
		Heater-Cathode Leakage Ehk=+100Vdc	---	---	Ihk:	---	---	---	---	20	---	µAdc
		Ehk=-100Vdc	---	---	Ihk:	---	---	---	---	20	---	µAdc
		Change in Transconductance(1) of individual tubes	---	---	ΔSm:	1600	---	---	---	---	---	µmhos
		Grid Current	---	---	Ic:	0	---	---	---	-1.5	---	µAdc
4.9.6.1	Miniature Tube Base Strain:	Note 16	---	---		---	---	---	---	---	---	
---	Glass Strain:	Note 17	2.5	I		---	---	---	---	---	---	

Ref.	Test	Conditions	AQL (%)	Insp Level or Code	Allowable Defectives per Characteristic: 1st Sample	Combined Samples	Sym.	LIMITS Min.	Max.	Units
	Acceptance Life Tests Note 24									
4.11.7	Heater Cycling Life Test:	Ef=7.5V; Heaters in parallel; Ehk=+135Vdc; Ec=Eb=0; Note 18	---	---	---	---		---	---	
4.11.4	Heater Cycling Life Test End Points:	Heater-Cathode Leakage Ehk=+100Vdc	---	---	---	---	Ihk	---	15	µAdc
		Ehk=-100Vdc	---	---	---	---	Ihk	---	15	µAdc
--	High Reliability Life Test:	Ec=0Vdc; Ehk=50 Vdc; Rk/hk=1200; Rg/g=0.25 Meg; TA=Room; Note 20	AFR 1.0%/1000 RFR 7.0%/1000					—		—
4.11.4	High Reliability Life Test End Points: (1000 hours)	Grid Current, Note 21	---	---			Ic:	0	-1.5	µAdc
		Plate Current(1), Note 21	---	---			Ib:	3.0	11.0	mAdc
4.11.5	Intermittent Life Tests:	Ehk=135Vdc; Ec=0; Rg=0.5 Meg; T Envelope = +160°C min.; Notes 19, 22, 23	---	---	---	---		---	---	

Ref.	Test	Conditions	AQL (%)	Insp. Level — Code	Allowable Defectives per Characteristic: 1st Sample	Combined Samples	Sym.	LIMITS Min.	Max.	Units
	Acceptance Life Tests Note 14 (Cont'd)									
4.11.4	Intermittent Life Test End Points: (2 and 20 Hours)	Change in Transconductance(1) of Individual Tubes	---	---	1	---	Δ_t^{Sm}:	---	10	%
4.11.4	Intermittent Life Test End Points: (500 Hours)	Note 24								
		Inoperatives; Note 25	---	---	1	2		---	---	
		Grid Current(1)	---	---	---	---	Ic:	0	-0.5	µAdc
		Heater Current	---	---	---	---	If:	160	193	mA
		Change in Transconductance(1) of Individual Tubes	---	---	---	---	Δ_t^{Sm}:	---	15	%
		Transconductance(2)	---	---	---	---	$\Delta\frac{Sm}{Ef}$:	---	15	%
		Heater-Cathode Leakage								
		Ehk=+100Vdc	---	---	---	---	Ihk:	---	7	µAdc
		Ehk=-100Vdc					Ihk:	---	7	µAdc
		Insulation of Electrodes								
		E(g-all)=-100Vdc	---	---	---	---	R:	250	---	Meg
		E(p-all)=-300Vdc					R:	250	---	Meg
		Total Defectives	---	---	2	4		---	---	
		Variables Control; Note 22	---	---	---	---		---	---	
		Change of Average	---	---	---	---	AvgΔ_t^{Sm}:	---	10	%
		Dispersion	---	---	---	---	ALD	---	500	µmhos
4.11.4	Intermittent Life Test End Points: (1000 Hours)	Note 24								
		Inoperatives; Note 25	---	---	1	2		---	---	
		Grid Current(1)	---	---	--	---	Ic:	0	-0.5	µAdc
		Heater Current	---	---	--	---	If:	160	196	mA
		Change in Transconductance(1) of Individual Tubes	---	---	---	---	Δ_t^{Sm}:	---	25	%
		Transconductance(2)	---	---	---	---	$\Delta\frac{Sm}{Ef}$:	---	20	%
		Heater-Cathode Leakage								
		Ehk=+100Vdc	---	---	---	---	Ihk:	---	7	µAdc
		Ehk=-100Vdc					Ihk:	---	7	µAdc
		Insulation of Electrodes								
		E(g-all)=-100Vdc	---	---	---	---	R:	100	---	Meg
		E(p-all)=-300Vdc					R:	100	---	Meg
		Total Defectives	---	---	2	4		---	---	
		Variables Control; Note 22	---	---	---	---		---	---	
		Change of Average	---	---	---	---	AvgΔ_t^{Sm}:	---	15	%
		Dispersion	---	---	---	---	ALD	---	530	µmhos
---	Interface Life Test:	Ef=6.3V; Heaters in Parallel; other electrodes disconnected; Note 26	---	---	---	---	t:	500	---	hours
4.11.4	Interface Life Test End Points:	Ef=5.7±.05Vdc; Heaters in parallel; Eb=50Vdc; Ec/Ib=1.0 mAdc; Notes 5, 27, 28	---	---	1	3	Ri:	---	50	ohms
	Packaging Requirements									
4.9.18.1.1	Carton Drop:	(d) Package Group 1; Carton Size B								

NOTES

1. This value is for operation under fixed bias conditions. With cathode bias, Rg g may be 0.25 megohm maximum for high-reliability operation and 1.0 megohm for normal operation.

2. Variables Sampling Procedure: See 4.1.1.7, MIL-E-1.

3. Tie 1k to 2k; 1g to 2g; and 1p to 2p.

4. The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding inoperatives and mechanical, shall be 1 percent. A tube having one or more defects shall be counted as one defective. MIL-STD-105, Inspection Level II, shall apply.

5. Test each unit separately.

6. Test each unit separately, with normal test-condition voltages applied to the opposite section.

7. Tubes shall be tested for continuity of all possible circuits, including shell, base, base sleeve, shield, and duplicate pin connections to the same electrode; for shorts between the tube elements or between the elements and the no-connection base pins; and for air leaks.

   During both continuity and shorts testing, the tube under test shall be tapped at least three times in each of two planes 90° to 120° apart with a tapper, which shall be adjusted to give an impulse of approximately one-half sine wave of 300±50 microseconds' duration, as measured 10 percent from the base, and having a minimum average amplitude equivalent to 80 G peak acceleration for T5-1/2 and larger tubes.

   During tapping, the tube shall be supported only by a socket and light finger or soft cushioned mechanical pressure on the dome of the bulb. The finger or mechanical pressure on the dome of the bulb shall be used only when necessary to prevent the tube from coming out of the socket and shall be so applied that it offers negligible restraint to lateral motion at the top of the bulb.

   The tap blows shall be delivered to the tube approximately two-thirds up on the seated height.

   The tapper impulse shall be measured with a Gulton Mfg. Co. type A-305 accelerometer, mounted in a standard production-type (replaceable cap and clips) T5-1/2 socket and having no other support. The tap blows shall be delivered to the accelerometer at the approximate midpoint of its seated height and in a direction parallel to the plane of maximum sensitivity of the accelerometer. The output of the accelerometer shall be coupled through a cathode follower and low-pass filter-amplifier combination to a suitable calibrated oscilloscope. The low-pass filter shall have a minimum high-frequency cutoff at 5000 cycles per second. The Gulton KA-1 test set on 5-kc filter position possesses appropriate characteristics.

   The short-indicator sensitivity, between adjacent elements, shall be defined as an equivalent resistance which persists for a period of time in excess of that determined by a limiting curve of resistance versus time duration passing through the following points:

Duration	Sensitivity
Permanent short	600,000 ohms
500 microseconds	500,000 ohms
100 microseconds	100,000 ohms
80 microseconds	1,000 ohms

The maximum voltage between adjacent elements during shorts test shall be 70 Vdc, and the minimum shall be 20 Vdc.

The tube under test shall be connected to the shorts test equipment with elements in sequence for single-section tubes, but like elements in the sections of a multisection tube may be paralleled, provided that the mechanical assembly of the tube structure is such that the possibility of a short due to section-to-section crossover jumpers is remote.

Tubes that give an indication of one or more of the following shall be rejected as inoperable:

(a) Either a permanent or tap short at any time during the tapping procedure
(b) Any open circuit
(c) Air leaks, as defined by 4.7.6, MIL-E-1.

8. Transconductance (2) is the percent change in transconductance (1) of an individual tube resulting from the change in Ef.

9. Prior to this test, tubes shall be preheated a minimum of 5 minutes with all sections operating at the conditions indicated below. Three-minute test is not permitted. Test within 3 seconds after preheating. Grid emission shall be the last test performed on the sample selected for the Grid Emission Test.

Ef	Ec	Eb	Rk/k	Rg/g
V	Vdc	Vdc	ohm	megohm
15.0	-8.5	250	0	0.5

10. In addition to the rejection criteria of 4.10.3.1, MIL-E-1, the output shall be read on a VU meter using a rejection limit of 5 VU. Five VU is the meter deflection obtained with a steady-state output of 3 mw from the amplifier.

11. The rejection level shall be set at the VU meter reading obtained during calibration.

12. The grid is driven with a pulse voltage as follows: egk = +40 V; prr = 1000; tp = 10 μs; tr = <1μs; tf = <1 μs (egk shall be defined as the instantaneous peak voltage between the grid and the negative end of the cathode resistor). Peak cathode current shall be measured by means of a high-impedance oscilloscope or equivalent device connected across a cathode resistor of 1.0 ohm. Preheat at Ef = 12.6 V for 5 minutes; no other voltages applied.

13. This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. Once a lot has passed, the 30-day rule shall apply. In the event of lot failure, the lot shall be rejected and the succeeding lots shall be subjected to this test until a lot passes. MIL-STD-105, sample size code letter F, shall apply.

14. Destructive tests: Tubes subjected to the following destructive tests are not to be accepted under this specification:

4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater-Cycling Life Test
4.11.5	Intermittent Life Test
--	Interface Life Test

15. A grid resistor of 0.1 megohm shall be added; however, this resistor shall not be used when a thyratron-type short indicator is employed.

16. Acceptance sampling procedure shall be in accordance with 20.2.6, Appendix C, MIL-E-1.

17. Glass Strain Procedure: All tubes subjected to this test shall have been sealed a minimum of 48 hours prior to conducting this test. All tubes shall be at room temperature. The entire tube shall be immersed in water at not less than 97°C for 15 seconds and immediately thereafter immersed in water at not more than 5°C for 5 seconds. The volume of water shall be large enough that the water temperature will not be apprectably affected by the test. The holder shall be in accordance with Drawing #245-JAN, and the tubes shall be immersed quickly. The tubes shall be so placed in the water that no contact is made with the containing vessel, nor shall the tubes contact each other. After the 5-second submersion period, the tubes shall be removed and allowed to return to room temperature on a wooden surface. After drying at room temperature for a period of 48 hours, the tubes shall be inspected and rejected on evidence of air leaks (ref. MIL-E-1, 4.7.6). Electrical rejects, other than inoperatives, may be used in the performance of this test.

18. The no-load to steady-state full-load regulation of the heater voltage supply shall be not more than 3.0 percent. This test shall be made on a lot-by-lot basis. A failure or defect shall consist of an open heater, open cathode circuit, heater-cathode short, or heater-cathode leakage current in excess of the specified heater-cycling life-test end point limit.

19. A stability check shall be made by reading Intermittent Life Test first sample at 2 hours and at 20 hours for transconductance (1). Tubes shall be within limits specified.

20. The High Reliability Life Test shall be conducted for 1000 hours under the specified conditions. The procedure shall be as follows:

(a) Life-test samples shall be selected from a lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing tubes which are outside the initial specification sheet limits for the relevant life-test end-point characteristics, such tubes shall be replaced by randomly selected acceptable tubes.

(b) The following single sampling plan shall be used:

Sample size n = 90
Acceptance number c = 2
T = 1000 hours

This plan assures an Acceptable Failure Rate (AFR) of 1 percent per 1000 hours with a 5-percent producer's risk and a Rejectable Failure Rate (RFR) of 7 percent per 1000 hours with a 10-percent consumer's risk (90-percent confidence level).

The failure rate to be expected in any reasonable application will be much less (possibly a factor of 10) than the RFR, because a manufacturer must produce a product of much higher quality in order to pass a reasonable proportion of his submitted lots.

(c) Early release of a lot is permissible at 500 hours, provided that the three previous lots were acceptable at 1000 hours (n = 80, c = 2) and the current lot is acceptable at 500 hours (n = 80, c = 1, T = 500). The test, however, shall be continued to completion (1000 hours).

(d) Tubes from the life-test sample may be returned to the lot at the conclusion of the 1000-hour test, provided that they meet all the initial-attributes limits of Measurements Acceptance Tests, Part I, plus leakage 4.8.1.

21. Both grid current and plate current shall be read under the High Reliability Life Test conditions and may be read on the life-test rack. Tubes that fail to read within specified limits owing to any abnormality (shorts, opens, leakage, low emission, etc.) shall be considered rejects.

22. Intermittent Life Tests:

(a) The Intermittent Life Test procedure shall be in accordance with 4.11.3.1(c) and Appendix C of MIL-E-1, except that early release is modified per (b) below. Also, all Intermittent Life Test samples must be continued to 1000 hours.

(b) Early release of a lot is permissible at 500 hours, provided that the three previous lots were acceptable at 1000 hours, the current lot is acceptable at 500 hours, and at least 20 tubes representing regular production extended to 2000 hours in the last 6 months' period have met the 1000-hour life-test end points at 2000 hours.

(c) The Variables Control shall consist of two tests, both made on Sm: (1) test for change of average and (2) test for dispersion. These tests are made on the first sample (n_1 = 20) as follows:

(1) Test for change of average: Calculate the average transconductance (1) at zero and reading period (500 or 1000 hours). Take the difference of these two averages, divide by the average at zero hours, and multiply by 100. This gives the percent change of average transconductance (1). Either the arithmetic mean or the median may be used as average for this test.

(2) Test for dispersion: The procedure shall be as follows, using either Method A or B:

Method A (using the average range):

(a.) Divide the 20-tube sample into 4 groups of 5 tubes each. Determine the range, R, of each group for transconductance.

(b.) Compute the average R values, $\overline{R}$. If $\overline{R}$ is equal to or less than the ALD, accept Sm for lot dispersion.

Method B (using the quasi-range):

Arrange 20 measurements in order of magnitude, find the difference between the second and nineteenth measurement of the sample so arr ... This is the quasi-range (QR_2) of a sample of 20. Multiply this quasi-range by 0.80; if QR_2 multiplied by 0.80 is equal to or less than ALD, accept Sm for lot dispersion.

23. Envelope temperature is defined as the highest temperature indicated when using a thermocouple of #40 BS or smaller diameter elements welded to a ring of 0.025-inch diameter phosphor bronze in contact with the envelope. The envelope-temperature requirement will be satisfied if a tube, having bogie Ib(±5%) under normal test conditions, is determined to operate at minimum specified temperature at any position on the life-test rack.

24. Order for Evaluation of Life-Test Defects: See 4.11.3.1.2, MIL-E-1.

25. An inoperative, as referenced in life test, is defined as a tube having one or more of the following defects: discontinuity (ref. note 7, except that tube shall not be tapped), permanent short (ref. note 7, except that tube shall not be tapped), air leaks (ref. MIL-E-1, 4.7.6).

26. The life-test sample shall consist of 20 tubes, and not more than one tube failure shall be permitted. In the event of rejection of the first sample, owing to failure of more than one tube, a second sample of 40 tubes shall be selected from the lot. Acceptance shall then be based on the combined first and second samples. The total tube failures from the combined first and second samples shall not exceed three. A life-test defect is defined as a failure to meet the life-test end-point limits as specified in the tube specification sheet. The life-test sample shall be read at zero hours and 500 hours (plus 48 hours, minus 24 hours).

27. Preheat approximately 5 minutes prior to testing, using either Ef = 11.4 V (heaters in series) or Ef = 5.7 V (heaters in parallel), other electrodes disconnected. No other test shall be made from the start of the Interface Life Test until after the measurement of the end-point characteristic following completion of the indicated minimum number of life-test hours.

28. The value of interface resistance shall be measured in the standard test circuit, Drawing #248-JAN. As an alternative, a test method known to correlate with the method and conditions specified in this specification sheet may be utilized.

*29. The minimum sample size shall be as specified in the following table. Use the AQL and inspection level specified for each individual test item to determine the minimum sample size code letter.

AQL (%)	Inspection level	Maximum LTPD (%)	Minimum sample size
0.4	II	3.5	Code L
2.5	I	12.9	Code I
2.5	L6	14.5	Code H
6.5	L6	24.8	Code G

30. Reference specification shall be of the issue in effect on the date of invitation for bid.

31. Life-test survival data shall be kept on all lots, and when 5 successive samples of 80 each have shown no more than 2 failures out of the total of 400, the manufacturer can qualify as a supplier under the next higher level of reliability. Refer to specification sheet 5814A-2.

*This provides improved lot quality assurance for initial test items by requiring larger minimum sample sizes.

General note:

(1) Each tube shall be marked with a lot-identification symbol, letter or figure, so that tubes of a given lot may be identified. A lot shall be defined as specified in the applicable section of MIL-E-1D.

(2) A summary of the manufacturer's conformance data for Initial Acceptance, Intermittent Life, and High Reliability Life Tests, indicating compliance with the specified acceptance requirements for each lot represented in the shipment, must be certified by a responsible member of the tube-manufacturing concern and supplied to the purchaser.

(3) One complete set of initial-test and life-test data for one acceptable lot shall be submitted to the qualifying agency, during each calendar year in which the tube type is produced, as verification of the manufacturer's continued conformance to the qualification requirements.

(4) For circuit design and application purposes, the user is referred to MIL-HNBK-211, in which the corresponding data sheet contains operation and performance parameters not normally a part of an acceptance specification.

SAMPLE II

MIL-E-1/
30 July 1959

MILITARY SPECIFICATION SHEET
ELECTRON TUBE, RECEIVING, TWIN TRIODE, MINIATURE
JAN-5814A-2

This specification covers highly reliable receiving type electron tubes and includes test requirements necessary to assure a maximum specified failure rate when used within the high reliability ratings. (See note 20.)

This specification sheet forms a part of the latest issue of Military Specification MIL-E-1.

Description: Twin Triode, Medium Mu, Reliable.

RATINGS:	Ef V	Eb Vdc	Ec Vdc	Ehk v	Rg/g Meg	Ik/k mAdc	Ic/g mAdc	Pp/p W	T Envelope °C	Alt. ft
High Reliability										
Design										
Maximum:	12.6 6.3	250	0	90	0.1 Note 1	10.0	2.0	1.0	130	60,000
Minimum:	12.0 6.0	---	-50	---	---	---	---	---	---	---
Normal Design										
Maximum:	13.8 6.9	330	0	100	0.5 Note 1	20	5.0	2.7	+165	60,000
Minimum:	11.4 5.7	---	-50	---	---	---	---	---	---	---
Test Cond.:	12.6	250	-8.5	0	---	---	---	---	---	---

Cathode: Coated Unipotential
Base: Miniature Button 9-pin

Diameter: 7/8 in. max.
Height: 2 - 3/16 in. max.

Pin No.:	1	2	3	4	5	6	7	8	9
Element:	2p	2g	2k	h	h	1p	1g	1k	hct

Envelope: T-6 1/2

The following tests shall be performed:
For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1. For miscellaneous requirements, see Paragraph 3.6 in MIL-E-1 headed "Performance."

Ref.	Test	Conditions:	AQL (%)	Insp. Level Code	Sym.	LIMITS, Note 2 Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Qualification Approval Tests											
3.1	Qualification Approval:	Required for JAN Marking	---	---								
---	Cathode:	Coated Unipotential	---	---								
3.4.3	Base Connections:		---	---								
4.9.20.3	Vibration(1):	Rp=2000; Note 3	---	---	Ep:	---	---	---	---	100	---	mVac
	Measurements Acceptance Test Part 1 Note 4 and 29											
4.10.8	Heater Current:		---	---	If:	---	169	175	181	---	13	mA
4.10.8	Heater Current:		0.4	II	If:	160	---	---	---	190	---	mA
4.10.15	Heater Cathode Leakage: Note 5	Ehk = +100 Vdc Ehk = -100 Vdc	0.4	II	Ihk: Ihk:	--- ---	--- ---	--- ---	--- ---	7 7	--- ---	µAdc µAdc
4.10.6.1	/Grid Current:	Rg/g=0.5Meg; Note 5	0.4	II	Ic1:	0	---	---	---	-0.5	---	µAdc
4.10.4.1	Plate Current (1):	Note 5	---	---	Ib:	---	9.0	10.5	12.0	---	3.5	mAdc
4.10.4.1	/Plate Current(1):	Note 5	0.4	II	Ib:	6.5	---	---	---	14.5	---	mAdc
4.10.4.1	Plate Current (2):	Ecc=-30Vdc; Rp=0.1 Meg; Note 6	0.4	II	Ib:	---	---	---	---	20	---	µAdc
4.10.9	Transconductance(1):	Note 5	---	---	Sm:	---	2000	2200	2400	---	450	µmhos
4.10.9	Transconductance(1):	Note 5	0.4	II	Sm:	1750	---	---	---	2650	---	µmhos

FSC 5960

Ref.	Test	Conditions	AQL (%)	Insp. Level or Code	Sym.	Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Measurements Acceptance Test Part 1, Notes 4 and 29 (Cont'd)											
---	Continuity and Short: (Inoperatives)	Note 7	0.4	II		---	---	---	---	---	---	
4.9.1	Mechanical:	Envelope Outline No. 6-7	---	---		---	---	---	---	---	---	
	Measurements Acceptance Test Part 2, Note 29											
4.8.2	Insulation of Electrodes:	Note 5; g-all = -100 Vdc	2.5	L6	R:	1000	---	---	---	---	---	Meg
		p-all = -300 Vdc			R:	1000	---	---	---	---	---	Meg
4.10.4.1	Plate Current(1) Difference Between Sections:		2.5	I	Ib:	---	---	---	---	3.5	---	mAdc
4.10.4.1	Plate Current(3):	Ec=-18Vdc; Note 5	2.5	I	Ib:	5	---	---	---	---	---	mAdc
4.10.9	Transconductance(2):	Ef =11.4V; Notes 5, 8	2.5	I	ΔSm/Ef:	---	---	---	---	15	---	%
4.10.6.1	Grid Emission:	Ef=15V; Ec=-30Vdc; Rg/g=0.5Meg; Notes 5, 9	2.5	I	Isc:	0	---	---	---	[illegible]	---	μAdc
4.10.3.1	RF Noise:	Ecal=7.0mVac; Ec=-9Vdc; Notes 3, 10	2.5	I		---	---	---	---	---	---	
4.10.3.5	Noise and Microphonics:	Ef=12.6 V; Ebb=300Vdc; Ec=0; Ecal=50mVac; Rk=1500; Ck=1000μf min; Rp=50,000; Rg=0; Notes 3, 11	2.5	I		---	---	---	---	---	---	
4.10.11.1	Amplification Factor:	Note 5	---	---	Mu:	---	16.2	17.0	17.8	---	1.8	
4.10.11.1	Amplification Factor:	Note 5	2.5	I	Mu:	15.5	---	---	---	18.5	---	
---	Pulse Cathode Current:	Ec1=-40Vdc; Notes 5, 12	2.5	Code H	ik:	200	---	---	---	---	---	ma
4.10.9	Transconductance(3):	Eb=100Vdc; Ec=0; Note 5	6.5	Code I	Sm:	2500	---	---	---	4000	---	μmhos
4.10.14	Capacitance:	No Shield; Note 5	6.5	Code K	Cgp:	1.20	---	---	---	1.80	---	μμf
		No Shield; Note 5			Cin:	1.25	---	---	---	1.95	---	μμf
		No Shield;			Cout 1:	0.30	---	---	---	0.70	---	μμf
		No Shield;			Cout 2:	0.20	---	---	---	0.60	---	μμf
4.9.12.1	Low Pressure Voltage Breakdown:	Pressure=55±5mm Hg.; Voltage = 500Vac	6.5	Note 13		---	---	---	---	---	---	
4.9.19.1	Vibration(2):	Rp=2000; G=10; F=40cps; Note 3	6.5	Code I	Ep:	---	---	---	---	100	---	mVac

Ref.	Test	Conditions	AQL (%)	Insp Level or Code	Sym.	LIMITS, Note 2 Min.	LAL	Bogie	UAL	Max.	ALD	Units
	Degradation Rate Acceptance Tests Notes 14 and 24											
4.9.20.5	Shock:	Hammer angle = 30°; Ehk = +100Vdc; Note 15	---	---		---	---	---	---	---	---	
4.9.20.6	Fatigue:	G=2.5; Fixed frequency; F=25 min., 60 max.	6.5	Note 13		---	---	---	---	---	---	
---	Post Shock and Fatigue Test End Points.	Vibration(2)	---	---	Ep	---	---	---	---	150	---	mVac
		Heater-Cathode Leakage										
		Ehk=+100Vdc	---	---	Ihk	---	---	---	---	20	---	µAdc
		Ehk=-100Vdc	---	---	Ihk	---	---	---	---	20	---	µAdc
		Change in Transconductance(1) of individual tubes	---	---	ΔSm	1600	---	---	---	---	---	µmhos
		Grid Current	---	---	Ic	0	---	---	---	-1.5	---	µAdc
4.9.6.1	Miniature Tube Base Strain:	Note 16	---	---		---	---	---	---	---	---	
---	Glass Strain:	Note 17	2.5	I		---	---	---	---	---	---	

Ref.	Test	Conditions	AQL (%)	Insp Level or Code	Allowable Defectives per Characteristic 1st Sample	Combined Samples	Sym.	LIMITS Min.	Max.	Units
	Acceptance Life Tests Note 14									
4.11.7	Heater Cycling Life Test:	Ef=7.5V; Heaters in parallel; Ehk=+135Vdc; Ec=Eb=0; Note 18	---	---	---	---		---	---	
4.11.4	Heater Cycling Life Test End Points:	Heater-Cathode Leakage								
		Ehk=+100Vdc	---	---	---	---	Ihk	---	15	µAdc
		Ehk=-100Vdc	---	---	---	---	Ihk	---	15	µAdc
---	High Reliability Life Test:	Ec=0Vdc; Ehk=30 Vdc; Rh/k=1200; Rg/g=0.25 Meg; TA=Room; Note 20	AFR 0.2%/1000 RFR 1.4%/1000							
4.11.4	High Reliability Life Test End Points: (1000 hours)	Grid Current, Note 21	---	---			Ic	0	-1.5	µAdc
		Plate Current(1), Note 21	---	---			Ib	5.0	11.0	mAdc
4.11.5	Intermittent Life Test:	Ehk=135Vdc; Ec=0; Rg/g=0.5 Meg; T Envelope=+165°C min.; Notes 19, 22, 23	---	---	---	---		---	---	

Ref.	Test	Conditions	AQL (%)	Insp. Level or Code	Allowable Defectives per Characteristic: 1st Sample	Combined Samples	Sym.	LIMITS: Min.	Max.	Units
	Acceptance Life Tests Note 14 (Cont'd)									
4.11.4	Intermittent Life Test End Points: (2 and 20 Hours)	Change in Transconductance(1) of Individual Tubes	---	---	1	---	Δ_t gm	---	10	%
4.11.4	Intermittent Life Test End Points: (500 Hours)	Note 24								
		Inoperatives; Note 23	---	---	1	2		---	---	
		Grid Current(1)	---	---	---	---	Ic	0	-0.5	µAdc
		Heater Current	---	---	---	---	If	160	193	mA
		Change in Transconductance(1) of Individual Tubes	---	---	---	---	Δ_t gm	---	15	%
		Transconductance(2)	---	---	---	---	Δ gm	---	15	%
		Heater-Cathode Leakage								
		Ehk=+100Vdc	---	---	---	---	Ihk	---	7	µAdc
		Ehk=-100Vdc					Ihk	---	7	µAdc
		Insulation of Electrodes								
		E(g-all)=-100Vdc	---	---	---	---	Ri	250	---	Meg
		E(p-all)=-300Vdc					Ri	250	---	Meg
		Total Defectives	---	---	2	4		---	---	
		Variables Control; Note 22	---	---	---	---		---	---	
		Change of Average	---	---	---	---	Avg Δ_t gm	---	10	%
		Dispersion	---	---	---	---	ALD	---	475	µmhos
4.11.4	Intermittent Life Test End Points: (1000 Hours)	Note 24								
		Inoperatives; Note 25	---	---	1	2		---	---	
		Grid Current(1)	---	---	---	---	Ic	0	-0.5	µAdc
		Heater Current	---	---	---	---	If	160	196	mA
		Change in Transconductance(1) of Individual Tubes	---	---	---	---	Δ_t gm	---	25	%
		Transconductance(2)	---	---	---	---	Δ gm	---	30	%
		Heater-Cathode Leakage								
		Ehk=+100Vdc	---	---	---	---	Ihk	---	7	µAdc
		Ehk=-100Vdc					Ihk	---	7	µAdc
		Insulation of Electrodes								
		E(g-all)=-100Vdc	---	---	---	---	Ri	100	---	Meg
		E(p-all)=-300Vdc					Ri	100	---	Meg
		Total Defectives	---	---	2	4		---	---	
		Variables Control; Note 22	---	---	---	---		---	---	
		Change of Average	---	---	---	---	Avg Δ_t gm	---	15	%
		Dispersion	---	---	---	---	ALD	---	900	µmhos
---	Interface Life Test:	Ef=6.9V; Heaters in Parallel; other electrodes disconnected; Note 26	---	---	---	---	t	500	---	hours
4.11.4	Interface Life Test End Points:	Ef=6.7 ; 05Vdc; Heaters in parallel; Ebb=0Vdc; Ic/Ipul. 0 mAdc; Notes 3, 27, 28	---	---	1	3	Ri	---	50	ohms
	Packaging Requirements									
4.9.18.1.1	Carton Drop:	(d) Package Group 1; Carton Size B								

NOTES

1. This value is for operation under fixed bias conditions. With cathode bias, Rg/g may be 0.25 megohm maximum for high-reliability operation and 1.0 megohm for normal operation.

2. Variables Sampling Procedure: See 4.1.1.7, MIL-E-1.

3. Tie 1k to 2k; 1g to 2g; and 1p to 2p.

4. The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding inoperatives and mechanical, shall be 1 percent. A tube having one or more defects shall be counted as one defective. MIL-STD-105, Inspection Level II, shall apply.

5. Test each unit separately.

6. Test each unit separately with normal test-condition voltages applied to the opposite section.

7. Tubes shall be tested for continuity of all possible circuits, including shell, base, base sleeve, shield, and duplicate pin connections to the same electrode; for shorts between the tube elements or between the elements and the no-connection base pins; and for air leaks.

During both continuity and shorts testing, the tube under test shall be tapped at least three times in each of two planes 90° to 120° apart with a tapper, which shall be adjusted to give an impulse of approximately one-half sine wave of 300±50 microseconds' duration, as measured 10 percent from the base, and having a minimum average amplitude equivalent to 80 G peak acceleration for T5-1/2 and larger tubes.

During tapping, the tube shall be supported only by a socket and light finger or soft cushioned mechanical pressure on the dome of the bulb. The finger or mechanical pressure on the dome of the bulb shall be used only when necessary to prevent the tube from coming out of the socket and shall be so applied that it offers negligible restraint to lateral motion at the top of the bulb.

The tap blows shall be delivered to the tube approximately two-thirds up on the seated height.

The tapper impulse shall be measured with a Gulton Mfg. Co. type A-305 accelerometer mounted in a standard production-type (replaceable cap and clips) T5-1/2 socket and having no other support. The tap blows shall be delivered to the accelerometer at the approximate midpoint of its seated height and in a direction parallel to the plane of maximum sensitivity of the accelerometer. The output of the accelerometer shall be coupled through a cathode follower and low-pass filter-amplifier combination to a suitable calibrated oscilloscope. The low-pass filter shall have a minimum high-frequency cutoff at 5000 cycles per second. The Gulton KA-1 test set on 5-kc filter position possesses appropriate characteristics.

The short-indicator sensitivity, between adjacent elements, shall be defined as an equivalent resistance that persists for a period of time in excess of that determined

554461 O-60-9

by a limiting curve of resistance versus time duration passing through the following points:

Duration	Sensitivity
Permanent short	600,000 ohms
500 microseconds	500,000 ohms
100 microseconds	100,000 ohms
60 microseconds	1,000 ohms

The maximum voltage between adjacent elements during shorts test shall be 70 Vdc, and the minimum shall be 20 Vdc.

The tube under test shall be connected to the shorts test equipment with elements in sequence for single-section tubes, but like elements in the sections of a multi-section tube may be paralleled, providing that the mechanical assembly of the tube structure is such that the possibility of a short due to section-to-section crossover jumpers is remote.

Tubes that give an indication of one or more of the following shall be rejected as inoperable:

(a) Either a permanent or tap short at any time during the tapping procedure
(b) Any open circuit
(c) Air leaks, as defined by 4.7.6, MIL-E-1.

8. Transconductance (2) is the percent change in transconductance (1) of an individual tube resulting from the change in Ef.

9. Prior to this test, tubes shall be preheated a minimum of 5 minutes with all sections operating at the conditions indicated below. Three-minute test is not permitted. Test within 3 seconds after preheating. Grid emission shall be the last test performed on the sample selected for the Grid Emission Test.

Ef	Ec	Eb	Rk/k	Rg/g
V	Vdc	Vdc	ohm	megohm
15.0	-8.5	250	0	0.5

10. In addition to the rejection criteria of 4.10.3.1, MIL-E-1, the output shall be read on a VU meter using a rejection limit of 5 VU. Five VU is the meter deflection obtained with a steady-state output of 3 mw from the amplifier.

11. The rejection level shall be set at the VU meter reading obtained during calibration.

12. The grid is driven with a pulse voltage as follows: egk = +40 V; prr = 1000; tp = 10 μs; tr =<1μs; tf =<1μs (egk shall be defined as the instantaneous peak voltage between the grid and the negative end of the cathode resistor). Peak cathode current shall be measured by means of a high-impedance oscilloscope or equivalent device connected across a cathode resistor of 1.0 ohm. Preheat at Ef = 12.6 V for 5 minutes; no other voltages applied.

13. This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. Once a lot has passed, the 30-day rule shall apply. In the event of lot failure, the lot shall be rejected and the succeeding lots shall be subjected to this test until a lot passes. MIL-STD-105, sample size code letter F, shall apply.

14. Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification:

4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater-Cycling Life Test
4.11.5	Intermittent Life Test
--	Interface Life Test

15. A grid resistor of 0.1 megohm shall be added; however, this resistor shall not be used when a thyratron-type short indicator is employed.

16. Acceptance sampling procedure shall be in accordance with 20.2.6, Appendix C, MIL-E-1.

17. Glass Strain Procedure: All tubes subjected to this test shall have been sealed a minimum of 48 hours prior to conducting this test. All tubes shall be at room temperature. The entire tube shall be immersed in water at not less than 97°C for 15 seconds and immediately thereafter immersed in water at not more than 5°C for 5 seconds. The volume of water shall be large enough that the water temperature will not be appreciably affected by the test. The holder shall be so placed in the water that no contact is made with the containing vessel, nor shall the tubes contact each other. After the 5-second immersion period, the tubes shall be removed and allowed to return to room temperature on a wooden surface. After drying at room temperature for a period of 48 hours, the tubes shall be inspected and rejected on evidence of air leaks (ref. MIL-E-1, 4.7.6). Electrical rejects, other than inoperatives, may be used in the performance of this test.

18. The no-load to steady-state full-load regulation of the heater voltage supply shall be not more than 3.0 percent. This test shall be made on a lot-by-lot basis. A failure or defect shall consist of an open heater, open cathode circuit, heater-cathode short, or heater-cathode leakage current in excess of the specified heater cycling life-test end-point limit.

19. A stability check shall be made by reading Intermittent Life Test first sample at 2 hours and at 20 hours for transconductance (1). Tubes shall be within limits specified.

20. The High Reliability Life Test shall be conducted for 1000 hours under the specified conditions. The procedure shall be as follows:

(a) Life-test samples shall be selected from a lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing tubes that are outside the initial specification sheet limits for the relevant life-test end-point characteristics, such tubes shall be replaced by randomly selected acceptable tubes.

(b) The following single sampling plan shall be used:

Sample size n = 400
Acceptance number c = 2
T = 1000 hours

This plan assures an AFR of 0.2 percent per 1000 hours with a 5-percent producer's risk and an RFR of 1.4 percent per 1000 hours with a 10-percent consumer's risk (90-percent confidence level)

The failure rate to be expected in any reasonable application will be much less (possibly a factor of 10) than the RFR, because a manufacturer must produce a product of much higher quality in order to pass a reasonable proportion of his submitted lots.

(c) Early release of a lot is permissible at 500 hours, provided that the thr previous lots were acceptable at 1000 hours (n = 400, c = 2) and the current lot is acceptable at 500 hours (n = 400, c = 1, T = 500). The test, however, shall be continued to completion (1000 hours).

(d) The total quantity of tubes to be life-tested under high-reliability conditions for qualification purposes may consist either of a single sample of 400 from one lot or the accumulated data from five successive samples of 80 tubes each, as long as they total two failures or less out of 400.

(e) Tubes from the life-test sample may be returned to the lot at the conclusion of the 1000-hour test, provided that they meet all the initial attributes limits of Measurements Acceptance Tests, Part I, plus leakage 4.8.1.

21. Both grid current and plate current shall be read under the High Reliability Life Test conditions and may be read on the life-test rack. Tubes that fail to read within specified limits owing to any abnormality (shorts, opens, leakage, low emission, etc.) shall be considered rejects

22. Intermittent Life Tests:

(a) The Intermittent Life Test procedure shall be in accordance with 4.11.3.1(c) and Appendix C of MIL-E-1, except that early release is modified per (b) below, and the Intermittent Life Test double sampling plan requires a first sample (n_1) of 40 tubes and a second sample (n_2), if necessary, of 80 tubes. All Intermittent Life Test samples must be continued to 1000 hours.

(b) Early release of a lot is permissible at 500 hours, provided that the three previous lots were acceptable at 1000 hours, the current lot is acceptable at 500 hours, and at least 20 tubes representing regular production extended to 2000 hours in the last 6 months' period have met the 1000-hour life-test end points at 2000 hours.

(c) The Variables Control shall consist of two tests, both made on Sm: (1) test for change of average and (2) test for dispersion. These tests are made on the first sample (n_1 = 40) as follows:

(1) Test for change of average: Calculate the average transconductance (1) at zero and reading period (500 or 1000 hours). Take the difference of these two averages, divide by the average at zero hours, and multiply by 100. This gives the percent change of average transconductance (1). Either the arithmetic mean or the median may be used as average for this test.

(2) Test for dispersion: The procedure shall be as follows, using either Method A or B:

Method A (using the average range):

(a.) Divide the 40-tube sample into 8 groups of 5 tubes each. Determine the range, R, of each group for transconductance.

(b.) Compute the average R values, $\overline{R}$. If $\overline{R}$ is equal to or less than the ALD, accept Sm for lot dispersion.

Method B (using the quasi-range):

Arrange 40 measurements in order of magnitude, find the difference between the third and thirty-eighth measurement of the sample so arranged. This is the quasi-range (QR_3) of a sample of 40. Multiply this quasi-range by 0.76. If QR_3 multiplied by 0.76 is equal to or less than the ALD, accept Sm for lot dispersion.

23. Envelope temperature is defined as the highest temperature indicated when using a thermocouple of #40 BS or smaller diameter elements welded to a ring of 0.025-inch-diameter phosphor bronze in contact with the envelope. Envelope-temperature requirements will be satisfied if a tube, having bogie Ib (±5%) under normal test conditions, is determined to operate at minimum specified temperature at any position on the life-test rack.

24. Order for Evaluation of Life-Test Defects: See 4.11.3.1.2, MIL-E-1.

25. An inoperative, as referenced in life test, is defined as a tube having one or more of the following defects: discontinuity (ref. note 7, except that the tube shall not be tapped), permanent short (ref. note 7, except that the tube shall not be tapped), air leaks (ref. MIL-E-1, 4.7.6).

26. The life-test sample shall consist of 20 tubes, and not more than one tube failure shall be permitted. In the event of rejection of the first sample owing to failure of more than one tube, a second sample of 40 tubes shall be selected from the lot. Acceptance shall then be based on the combined first and second samples. The total tube failures from the combined first and second samples shall not exceed three. A life-test defect is defined as a failure to meet the life-test end-point limits as specified in the tube specification sheet. The life-test sample shall be read at zero hours and 500 hours (plus 48 hours, minus 24 hours).

27. Preheat approximately 5 minutes prior to testing, using either Ef = 11.4 V (heaters in series) or Ef = 5.7 V (heaters in parallel), other electrodes disconnected. No other test shall be made from the start of the Interface Life Test until after the measurement of the end-point characteristic following completion of the indicated minimum number of life-test hours.

28. The value of interface resistance shall be measured in the standard test circuit, Drawing #248-JAN. As an alternative, a test method known to correlate with the method and conditions specified in this specification sheet may be utilized.

*29. The minimum sample size shall be as specified in the table below. Use the AQL and inspection level specified for each individual test item to determine the minimum sample size code letter.

AQL (%)	Inspection level	Maximum LTPD (%)	Minimum sample size
0.4	II	3.5	Code L
2.5	I	12.9	Code I
2.5	L6	14.5	Code H
6.5	L6	24.8	Code G

30. Reference specification shall be of the issue in effect on the date of invitation for bid.

*This provides improved lot quality assurance for initial-test items by requiring larger minimum sample sizes.

31. Life-test survival data shall be kept on all lots, and when 10 successive samples of 400 each have shown no more than 2 failures out of the total of 4000, the manufacturer can qualify under the next higher level of reliability. Maintaining qualification requires no more than 2 failures out of the latest 10 lots, as each new lot is added and the earliest one deleted. Refer to specification sheet 5814A-3 (AFR 0.02%, RFR 0.1% per 1000 hours). (An example of this sheet is not included in this report.)

General notes:

(1) Each tube shall be marked with a lot-identification symbol, letter or figure, so that tubes of a given lot may be identified. A lot shall be defined as specified in the applicable section of MIL-E-1D.

(2) A summary of the manufacturer's conformance data for Initial Acceptance, Intermittent Life, and High Reliability Life Tests, indicating compliance with the specified acceptance requirements for each lot represented in the shipment must be certified by a responsible member of the tube-manufacturing concern and supplied to the purchaser.

(3) One complete set of initial-test and life-test data for one acceptable lot shall be submitted to the qualifying agency, during each calendar year in which the tube type is produced, as verification of the manufacturer's continued conformance to the qualification requirements.

(4) For circuit design and application purposes, the user is referred to MIL-HNBK-211, in which the corresponding data sheet contains operation and performance parameters not normally a part of an acceptance specification.

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